NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

EVALUATION OF THE BOEING PAN AIR TECHNOLOGIES CODE (A502I) THROUGH PREDICTION OF SEPARATION FORCES ON THE GBU-24

by

Matthew A. LeTourneau

March, 1996

Thesis Advisor: Max F. Platzer

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
March 1996

3. REPORT TYPE AND DATES COVERED
Master's Thesis

4. TITLE AND SUBTITLE EVALUATION OF THE BOEING PAN AIR TECHNOLOGIES CODE (A502I) THROUGH PREDICTION OF SEPARATION FORCES ON THE GBU-24

5. FUNDING NUMBERS

6. AUTHOR(S) LeTourneau, Matthew, A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

The Boeing PAN AIR Technologies code (A502i) is investigated to explore its suitability for determination of separation forces on ordnance. To this end, A502i is first assessed by applying it to three problems for which other solutions and experimental data are available, i.e. steady flow past a rectangular, parabolic arc wing and a delta wing at both subsonic and supersonic conditions. Good agreement is found in all cases. A502i is then applied to the GBU-24's being in two configurations for a subsonic case and a supersonic case. Good agreement is found with data obtained from wind tunnel experiments for low angles of attack.

14. SUBJECT TERMS A502i, Panel Methods, Potential FLow, Geometry Modelling, GBU-24

15. NUMBER OF PAGES 116

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

Approved for public release; distribution is unlimited.

EVALUATION OF THE BOEING PAN AIR TECHNOLOGIES CODE (A502I) THROUGH PREDICTION OF SEPARATION FORCES ON THE GBU-24

Matthew A. LeTourneau
Lieutenant, United States Navy
B.S., The George Washington University, 1988

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
March 1996

Author: Matthew A. LeTourneau
Matthew A. LeTourneau

Approved by: Max F. Platzer
Max F. Platzer, Thesis Advisor

Ismail H. Tuncer
Ismail Tuncer, Second Reader

Daniel J. Collins
Daniel J. Collins, Chairman
Department of Aeronautics and Astronautics

ABSTRACT

The Boeing PAN AIR Technologies code (A502i) is investigated to explore its suitability for determination of separation forces on ordnance. To this end, A502i is first assessed by applying it to three problems for which other solutions and experimental data are available, i.e. steady flow past a rectangular, parabolic arc wing and a delta wing at both subsonic and supersonic conditions. Good agreement is found in all cases. A502i is then applied to the GBU-24's being in two configurations for a subsonic case and a supersonic case. Good agreement is found with data obtained from wind tunnel experiments for low angles of attack.

TABLE OF CONTENTS

ACKNOWLEDGEMENT

The author wants to thank Dr. Alex Cenko of NAWC/AD Warminster whose assistance, guidance and tutelage made this thesis possible.

I. INTRODUCTION

In the past, ballistic trajectory determination for manual or computer predicted ordnance delivery from an aircraft was determined through measurement of separation forces on the piece of ordnance via wind tunnel or captive carry measurements. The advent of panel method codes using linearized potential theory, such as A502i, or its full potential version TranAir, allow for a cheaper and safer method of predicting separation forces. Furthermore, A502i allows for any arbitrary configuration to be modelled within the limitations of the number of panels and networks allowed and excluding transonic flow.

The purpose of this work was to determine the separation forces on a GBU-24 carried by an F-14 on stations 3 or 6 or both. It was also the purpose of this work to provide an analysis of the code itself to see if it is a viable tool for the study of flow characteristics over arbitrary wing configurations for use in the Naval Postgraduate School's (NPS) Department of Aeronautics and Astronautics. The majority of the work was conducted on the NPS computer systems. The Department of Aeronautics and Astronautics Silicon Graphics Incorporated (SGI) workstations were utilized for most of the input files as well as the execution of the code. Due to the amount of disk space required, storage of the output files took place on the NPS Computer Center's Y-MP EL98 Cray computer. The bulk of the GBU-24 data was calculated using the SGI workstations at the Naval Air Warfare Center in Warminster.

The scope of this analysis was to understand the capabilities of the A502i code. The approach was to validate A502i against existing data and linear theory. The code was run for three different geometries under assorted Mach and AOA conditions. Comparisons were made for each of the geometries.

II. OVERVIEW OF THE A502i CODE

The A502i code is used to computationally analyze inviscid subsonic or supersonic flows about arbitrary configurations. The code differs from other panel methods in that it is a higher order panel method; that is, the singularity strengths are not constant on each panel. A502i solves the linearized potential flow boundary-value problem at subsonic and supersonic Mach numbers.

The aerodynamic solution provides surface flow properties (flow directions, pressures, Mach number), configuration forces and moments, sectional forces and moments, and pressures. Additionally, A502i calculates flow properties in the flow-field points and flow-field streamlines. Results are limited to subsonic and supersonic cases (transonic cases excluded) with attached flow. Results are not usually applicable to cases where viscous effects and separation are dominant.

A. THEORY

The basic equations describing the flow of a viscous, compressible, heat-conducting fluid are the Navier-Stokes equations. These are:

(a) The continuity equation,

$$\frac{\partial \rho}{\partial t} + \nabla \bullet (\rho \vec{V}) = \frac{\partial \rho}{\partial t} + \sum_{i=1}^{3} \frac{\partial (\rho V_i)}{\partial x_i} = 0 \tag{2.1}$$

where $\nabla = (\frac{\partial}{\partial x_1}, \frac{\partial}{\partial x_2}, \frac{\partial}{\partial x_3})$ is the gradient operator with respect to the location vector $\vec{x} = (x_1, x_2, x_3)$, and where the conventional index notation is used instead of $\vec{x}=(x,y,z)$. In addition, t is time, $\rho(\vec{x},t)$ is the density and $\vec{V}(\vec{x},t)$ is the velocity vector, with components $\vec{V} = (V_1, V_2, V_3)$.

(b) The conservation of momentum equation,

$$\frac{\partial}{\partial t}(\rho V_j)+\sum_{i=1}^{3}\frac{\partial}{\partial x_i}(\rho V_i V_j)=\frac{-\partial p}{\partial x_j}+\sum_{i=1}^{3}\frac{\partial}{\partial x_i}\tau_{ji}+\rho f_j \quad (j=1,2,3) \tag{2.2}$$

where τ_{ij} is the deviatoric portion of the stress tensor which vanishes for a frictionless fluid, $\vec{f}(\vec{x},t)$ is an external body force per unit mass exerted on the fluid, and $p(\vec{x},t)$ is the pressure.

(c) The conservation of energy equation

$$\begin{aligned}\frac{\partial}{\partial t}(\rho e+\frac{1}{2}\rho|\vec{V}|^2+p)+\sum_{i=1}^{3}\frac{\partial}{\partial x_i}[(\rho e+\frac{1}{2}\rho|\vec{V}|^2+p)V_i]\\ =\frac{\partial p}{\partial t}+\sum_{i,m}\frac{\partial}{\partial x_i}(\tau_{im}V_m+k\frac{\partial T}{\partial x_i})+\rho\sum_i f_i V_i\end{aligned} \tag{2.3}$$

where $e(\vec{x},t)$ is the internal energy of the fluid, k is the coefficient of heat conductivity for the fluid, and $T(\vec{x},t)$ is the temperature.

(d) The equation of state

$$f(\rho, p, T)=0 \tag{2.4}$$

where the function f depends on the type of fluid. The derivations of these equations can be found in Refs. 1,2 and 3.

The Navier-Stokes equations can be simplified by the neglect of viscosity, which is equivalent to setting the deviatoric stress tensor to zero. Combining the momentum and continuity equations yields

$$\rho\frac{dV_j}{dt}=-\frac{\partial p}{\partial x_j}+\rho f_j \quad j=1,2,3 \tag{2.5}$$

where the convective derivative operator is defined as

$$\frac{d}{dt}=\frac{\partial}{\partial t}+\sum_i V_i\frac{\partial}{\partial x_i}$$

Equation (2.5) is referred to as Euler's equation. The continuity and energy equations can

Equation (2.5) is referred to as Euler's equation. The continuity and energy equations can be reduced to

$$\rho \frac{d}{dt}\left(\frac{1}{2}|\vec{V}|^2\right) = -\vec{V} \bullet \nabla p + \rho \vec{V} \bullet \vec{f} \tag{2.6}$$

and the rate of increase of heat per unit mass is given by

$$q = \frac{1}{\rho} \nabla \bullet (k \nabla T) = \frac{d\rho}{dt} + p \frac{d}{dt}\left(\frac{1}{\rho}\right) \tag{2.7}$$

Equations 2.5, 2.6 and 2.7 can be reduced to a single equation when four further assumptions are made. First, assume isentropic flow, thus

$$q=0 \tag{2.8}$$

Second, assume irrotationality

$$\nabla x \vec{V} = 0 \tag{2.9}$$

which allows for the introduction of the potential function [Refs 2,3]

$$\nabla \Phi = \vec{V} \tag{2.10}$$

Third, assume the existence of a freestream potential Φ_∞, whose gradient is the uniform velocity $\vec{V}_\infty$ attained at points sufficiently distant from the disturbance being analyzed, and thus write

$$\phi = \Phi - \Phi_\infty \tag{2.11}$$

and

$$\vec{V} = (u, v, w) = \nabla \Phi = \nabla \Phi_\infty + \nabla \phi = \vec{V}_\infty + \nabla \phi \tag{2.12}$$

The quantities ϕ and $\vec{v}$ are called the perturbation potential and velocity [Ref 3]. Fourth, assume that

$$|\vec{v}|^2 \ll a_\infty \tag{2.13}$$

everywhere, where a_∞ is the freestream speed of sound.

Based on these four assumptions, the unsteady potential equation is obtained [Refs 1,3]:

$$
\begin{aligned}
&(1-M_\infty^2)\phi_{xx}+\phi_{yy}+\phi_{zz}-2M_\infty^2\phi_{xt}-M_\infty^2\phi_{tt}\\
&=M_\infty^2[\frac{1}{2}(\gamma-1)(2u+2\phi_t+|\vec{v}|^2)\nabla^2\phi\\
&+(2u-u^2)\phi_{xx}+v^2\phi_{yy}+2vw\phi_{yz}+w^2\phi_{zz}\\
&+2(1+u)(v\phi_{xy}+w\phi_{xz})+2(uu_t+vv_t+ww_t)]
\end{aligned}
\tag{2.14}
$$

Assuming the flow conditions do not change with time yields the steady non-linear potential equation.

$$
\begin{aligned}
&(1-M_\infty^2)\phi_{xx}+\phi_{yy}+\phi_{zz}\\
&=M_\infty^2[\frac{1}{2}(\gamma-1)(2u+|\vec{v}|^2)\nabla^2\phi\\
&+(2u+u^2)\phi_{xx}+v^2\phi_{yy}+2vw\phi_{yz}+w^2\phi_{zz}\\
&+2(1+u)(v\phi_{xy}+w\phi_{xz})]
\end{aligned}
\tag{2.15}
$$

When M_∞=0, equation (2.15) reduces to Laplace's equation,

$$\nabla^2\phi=0 \tag{2.16}$$

For the case of $M_\infty \neq 0$, the following is supposed,

$$M_\infty^2|\vec{v}| \ll 1-M_\infty^2 \tag{2.17}$$

$$M_\infty^2|\vec{v}| \ll 1 \tag{2.18}$$

which are small perturbation assumptions [Refs. 1,2]. With these assumptions the steady non-linear potential equation reduces to the Prandtl-Glauert equation [Ref 1]:

$$(1-M_\infty^2)\phi_{xx}+\phi_{yy}+\phi_{zz}=0 \tag{2.19}$$

Through a coordinate transformation [Refs. 1,2,3], the Prandtl-Glauert equation can be re-written as:

$$s\phi_{\bar{x}\bar{x}} + \phi_{\bar{y}\bar{y}} + \phi_{\bar{z}\bar{z}} = 0 \tag{2.20}$$

where when s=1, it is the subsonic case and Laplace's equation applies and when s=-1, it is the supersonic case and the wave equation applies. Applying Green's third identity [Ref. 1] yields the following integral equation,

$$\phi(P) = -\frac{1}{4\pi}\int_s\int [\frac{\sigma}{R} - \mu\hat{n} \bullet \nabla\frac{1}{R}]dS \tag{2.21}$$

where σ represents the source strength and μ represents the doublet strength. When supplemented with boundary conditions, it is equation (2.21) that A502i solves.

A502i solves equation (2.21) through a discretization process. The general idea of the process falls into two parts. The first is developing finite dimensional approximate representation formulas for the singularity functions, which creates a system of equations with unknown coefficients, λ_i. The second part involves solving the set of equations for all λ_i. This allows for completely determining the source and doublet functions. Then, by virtue of equation (2.21), the potential function $\phi(P)$ is determined for all points P, solving the problem.

The features of A502i which distinguish it from predecessors are three-fold. The first is a feature known as "continuous geometry", the second is linear source and quadratic doublet variation, the third is continuity of doublet strength.

Most panel methods approximate the configuration geometry with panels whose planform is a quadrilateral. Thus, if the panels themselves are planar, only a small class of configurations (such as cylinders and flat wings) can be described without gaps being left between panels. These gaps are generally small, except for highly twisted surfaces. The

gaps cause little numerical error in subsonic flow, but in supersonic flow, the cumulative effect of the gaps is serious [Ref. 1]. The problem is not associated with leakage of flow through the gaps, but with the doublet strength jumping abruptly from a non-zero value to zero at a panel edge which does not exactly meet the adjacent edge. In A502i, gaps are closed by means of panels which are comprised of several planar regions.

The feature of linear source and quadratic doublet variation is what makes A502i a higher order panel method. The basis function corresponding to a source parameter is locally linear, while the basis function corresponding to a doublet parameter is locally quadratic. This is what allows for A502i to find supersonic solutions. Numerical solution of the wave equation is far more sensitive to the numerical idiosyncracies of a panel method than is the solution of Laplace's equation for subsonic flow. Experimental evidence [Ref. 1] indicates that exact surface analysis is not feasible in supersonic flow without doublet continuity, thus the potential for numerical error is greatly reduced by requiring the doublet singularity strength to be continuous across panels.

B. GENERAL A502i USAGE

The use of the A502i code consists of generating an input file, which can be arbitrarily named, and which contains the information defining the geometry of the configuration, flow field points of interest, the flow conditions and wakes. The process of building a geometry is difficult in that A502i is particular about its input format. Simple configurations, such as a rectangular, planform wing can be modelled manually, but more complex structures require a pre-processing program, such as MACGS, where a geometry can be graphically built. MACGS will output a data file in a format that, with minor modifications, via another pre-processing program that can move the data from three columns to six columns, will be readily usable by A502i. Currently, the school does not have a copy of MACGS, but it can be acquired through McDonnell-Douglas. To complete

this thesis, MACGS was used on the SGI workstations at NAWC Warminster. Wakes also must be constructed in the same manner as the structure to be analyzed. More detailed instructions on the specifics of wakes and surface geometries can be found in Ref. [4]. Appendix A is a portion of an output file, but lines 1 thru 1120 are an exact duplicate of the input file.

1. Running A502i with an Existing Executable

Assuming an A502i executable file (e.g., A502) has already been placed in a user executable directory (e.g., /usr/local/bin), the only other necessary items needed to produce a set of A502i output files is the input file and a large amount of storage space. Anything modelled with more than one thousand panels total will use more than one hundred mb of disk space. If the maximum number of panels (20,000) is used, the disk space required will be on the order of 2 gb.

To run A502i, enter after the UNIX prompt:

A502 <*input file* > *output file*

Prior to running the code, it is highly recommended that a Cray account be opened and linked to the department's SGI workstations. This is done by assigning the same user i.d. number to the Cray account as is assigned to the account with the department. User i.d. numbers can be changed by the computer center at the user's request. This is required due to the limited disk space available to individual accounts in the department. Once an account is opened, log on to a department workstation, change directories to an existing Cray directory, for example (after the UNIX prompt):

cd /jedi/d1/maletour

Transfer the input file to the Cray directory and execute the code. The screen will display what portion of the code it is performing and how long it took to perform each portion in CPU time. The code outputs numerous files in addition to the arbitrarily named output file.

The two output files of interest, in the vast majority of cases, are the arbitrarily named output file and the ft13 file. In order to run another solution all output files must be deleted or renamed prior to re-executing the code. Relevant results should not be kept on the Cray account as files on disks d1, d2 and u1 are considered temporary storage and subject to erasure after a period of time.

2. Creating an A502i Input File

The input file, which can be arbitrarily named, consists of two portions, the largest being the geometry data. Appendix A is a complete recreation of the input file for the GBU-24 with canards. The file begins with line 1, $TITLE, and ends with line 1120, $END. The line numbers are for reference only and are not part of the actual input file. The first portion consists of creating the initial conditions, i.e., the free-stream Mach number and angle of attack, the type of analysis to be performed, i.e., solution or datacheck, what types of output that are to be included in the arbitrarily named output file, and reference points to be used in calculating forces and moments. The geometry data consists of the points that bound each panel, that in turn belong to a specific group of panels that make up a network. The overall structure being modelled consists of a series of networks. A502i can run up to 150 networks and or 20,000 panels with a limit of 8,000 panels per network. Referencing Appendix A, line 28 represents the first network of the model, a canard. Line 29 represents the number of networks that will be classified under this $POINTS statement. Line 30 indicates what kind of surface the network will be, a three-dimensional surface with flow properties to be calculated, a wake and a base are several examples. Line 31 is the number of y points and the number of x points respectively that make up the grid of that network. Line 32 is where the panel points start. Reference 4 contains detailed instructions on the options and meaning of each of the non-geometry inputs, including some capabilities not shown in Appendix A.

Two types of solutions can be run, a datacheck and a full solution. Reference 4 explains how to enter either one into the input file. The datacheck only analyzes the geometry. This can be accomplished in a matter of seconds for a simple geometry as it is only running the first several portions of the code. The full solution can take a couple of hours for a geometry of the size of 4,000 panels. The datacheck should be run once the geometry has been modelled. It will check for any panel edges that do not abut properly, and when column 4 of line 20 in Appendix A is a 1, the datacheck will list the unit normal vectors, which must be facing outward. The datacheck will also see if the wakes are attached properly. A502i is capable of giving warnings both on-screen and in the arbitrarily named output file when an edge or a wake is not modelled properly, but it only lists the unit normal vectors. The directions of the vectors must be manually checked by the user. The full solution performs the datacheck first, so the data is repeated in the arbitrarily named output file. Appendix B is a portion of the output file that contains the summary of facing surfaces. Each panel edge is looked at to see what it abuts against. Sections such as wingtips, leading edges of a flat plate or any surface that does not need a wake attached, but is unabutted to any other panel on that edge will draw probable error messages or warnings from the code. The user must ensure that the edge is not supposed to abut against anything or need a wake attached. If that is the case, the warnings may be ignored. Appendix D is the first page of the portion of the output file that lists the unit normal vectors. The three columns under zc are the x-y-z coordinates of the given panel's center. The three columns under znc are the x-y-z coordinates of the unit normal vector. In most cases, when the y coordinates are of the same sign, then the unit normal vector is pointing outward.

C. GEOMETRY MODELLING

Five geometries needed to be modelled, each of increasing complexity. Modelling proved to be the most difficult task, in that A502i is a FORTRAN code and is very format sensitive, but the sheer number of points that need to be generated can take a lot of time and the order those points are listed in the input file is what determines whether or not the shape is correctly modelled. Of the five geometries modelled, none were done completely manually. A spreadsheet was used for generating the parabolic arc airfoil and the deltawing since those structures can be constructed out of one network, excluding wingtips and wakes, and the surface can be defined by a mathematical function. The bombs and the F-14 required the use of MACGS to be properly modelled. MACGS is indifferent as to the order that geometries are built, and often doesn't require many coordinate inputs if building a model on top of an existing IGS file. The output file from MACGS is automatically formatted and the points placed in the appropriate order for A502i to understand. Although, the order may be reversed where the unit outward normal vector is concerned. MACGS has the ability to output files in several different panel method code input formats, including PMARC. Reference 4 gives detailed instructions on how to properly order points to build a group of networks that will model a geometry. A502i uses a right-handed coordinate system that is similar to an aircraft body axes. When put in terms of a wing, the x axis is positive from leading edge to trailing edge. The z axis is positive up and the y axis is positive out the right wing

1. The Parabolic Arc Airfoil

The parabolic arc airfoil is the simplest of all the geometries. The airfoil has a chord of five and a span of ten. The maximum thickness is .15. The model consists of approximately 600 panels, including the wake and wingtips. A spreadsheet was used to develop the geometry portion of the input file. Line 32 of Appendix A demonstrates the

format that the spreadsheet used. Rows consist of two points, with coordinates x1, y1, z1, x2, y2, z2 using a format of 6F10.0. The chord was divided into 25 points (x coordinate) from trailing edge to leading edge and then another 25 points from leading edge to trailing edge (bottom half). The span was divided into 12 points (y coordinate) from left to right. Due to the symmetry of a rectangular planform, the y coordinate was constant along the 50 x coordinates that constituted a chordwise cross-section. To attain a maximum thickness of .15 the formula,

$$z = .3 * \left(\frac{x}{c} - \frac{x}{c^2}\right) \tag{2.22}$$

was utilized to generate the values of the z coordinates. The wingtips simply connect the x coordinate on the top side with it's symmetrical counterpart on the bottom side. Due to a trailing edge composed of a straight line, the wake is modelled by a single panel that spans the trailing edge and has a length aft of 100. Figure 2.1 shows the panel distribution across the top surface of the parabolic arc airfoil, where the thickness is represented by the color scheme. A panel and a point are numbered to show how they were entered into the input file.

2. The Deltawing

The deltawing represented a step up in complexity over the parabolic arc airfoil. The chordwise cross-section is parabolic, while the spanwise cross-section is linear. The procedure for building the geometry on a spreadsheet was the same as that for the parabolic arc airfoil, only the chord length is not constant along the span. For simplicity in design, the number of panels per column of panels is constant on the deltawing, as on the parabolic arc airfoil. This means an increasing panel density in the direction of the wing tip. The wake is modelled the same as the airfoil. The right wingtip ended in a point, so no extra panelling was needed to close any gaps. The symmetry of the deltawing allowed for

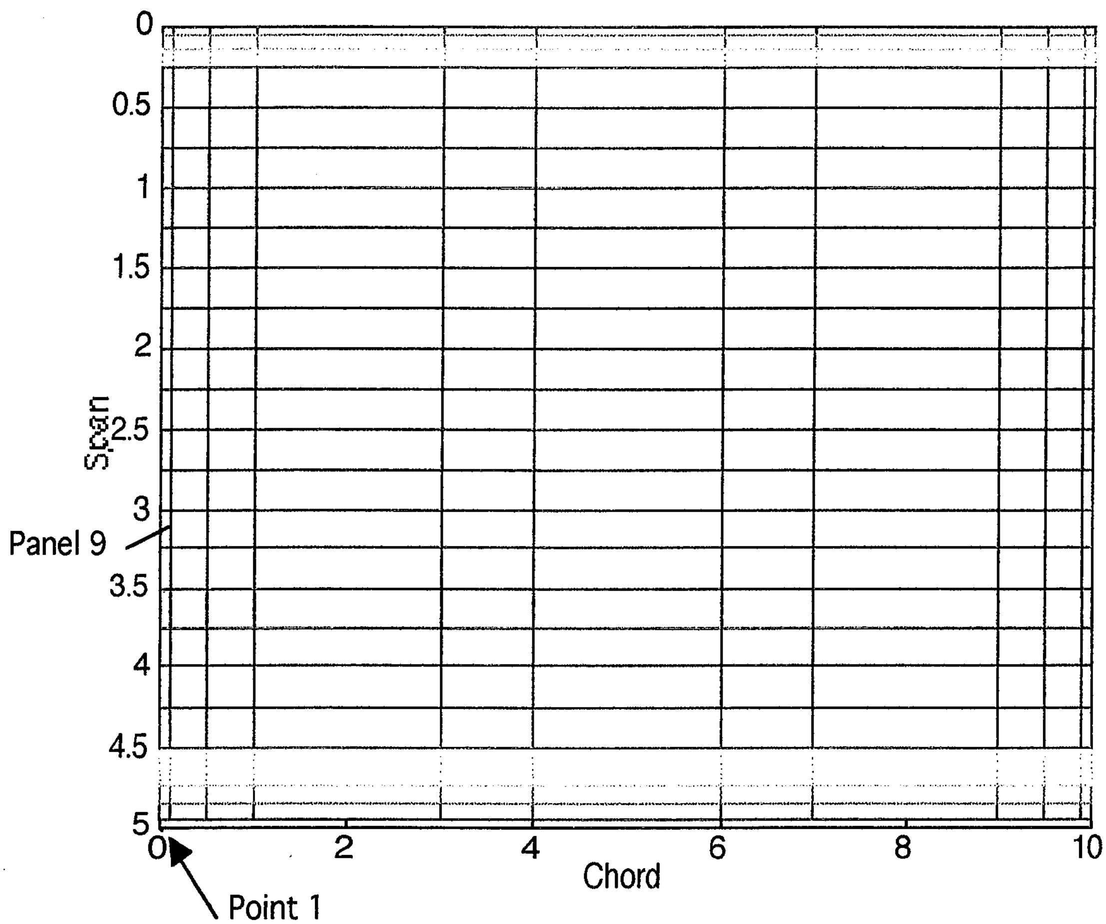

Figure 2.1 Parabolic Arc Panel Distribution

further simplification and reduction of the code's run time by only modelling from the centerline to the right tip. A502i allows the user to stipulate whether there is symmetry in the x-z plane and or the x-y plane (see line 5 and 6 of Appendix A). This means that the gap between the top and bottom panels at the center line does not need to be bridged as in the parabolic arc airfoil (symmetry could have also been used in the airfoil's case). The chord of the deltawing has a length of 90 and the semi-span has a length of 15. The maximum thickness occurs midway along the centerline and is .05. The model consists of 880 panels. Figure 2.2 shows the panel distribution along the top surface of the deltawing.

Thickness is represented by the color scheme.

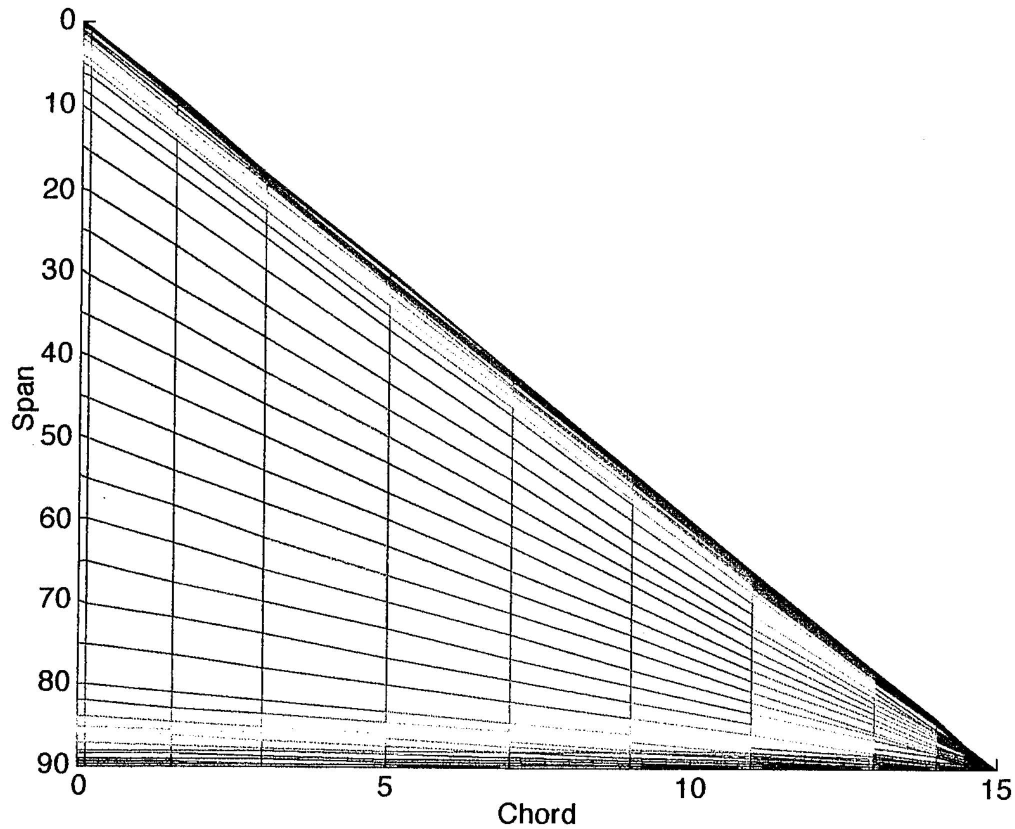

Figure 2.2 Panel Distribution of Deltawing

3. GBU-24

Wind tunnel experiments were run on the GBU-24 without canards attached, so it was deemed relevant to build a model with and without canards as a comparison of the code's performance. The model of the GBU-24 was too complex to build with a spreadsheet, so MACGS was used. The bomb was modelled at NAWC Warminster by superimposing a group of networks on top of an IGS file being displayed by MACGS. The complete configuration consists of approximately 1300 panels. Figures 2.3 and 2.4 are displays of the GBU-24 with canards, with Figure 2.4 including the wakes. Figure 2.5

is included to show how the GBU-24 model was assembled. Each different color represents a network.

Several features of the geometry are relevant to point out. Two of them are modifications made to the geometry that differ from the actual dimensions of the bomb. Dr. Alex Cenko of NAWC Warminster has extensive experience with modelling stores in A502i. The modifications were made on his knowledge of how to get the most accurate results from the code when modelling stores. The first is to model the fins and canards as flat plates, i.e., no thickness, which A502i allows you to do through a single numerical change in the input code for each network that represents a flat plate (see line 30 of Appendix A). The fins and canards are extremely thin when compared to the rest of the bomb, and to add a third dimension to the geometry complicates the construction of the fin or canard for several reasons. The leading and trailing edges must be sharp and the surface the fin or canard attaches to would have to be modified to abut properly with two edges instead of one. Experience has shown that the simpler version yields accurate predictions. A502i is an inviscid code, so it cannot take into account separation effects on its own. The GBU-24 does not have a flat base. In reality, it is more bullet nosed in shape. However, at the speeds with which the bomb is being analyzed, separation does occur near the trailing edge of the bomb. Experience has shown that truncating the end into a flat base and designating it a separated flow region through an appropriate input (see line 702, column 1, Appendix A) yields better results than attempting to model the bomb to exact physical dimensions. The last feature to point out are the wakes, as seen in Figure 2.4. A502i has a limitation in that the wakes must be modelled by the user, and they have the same abutment requirements as physical surfaces. Regardless of angle of attack, the wakes remain stationary with respect to the body to which they are attached. At higher angles of attack, the wakes are no longer close to paralleling the free-stream velocity. Remodelling the wakes is nearly an impossible task. The fin and base wakes would not be too difficult

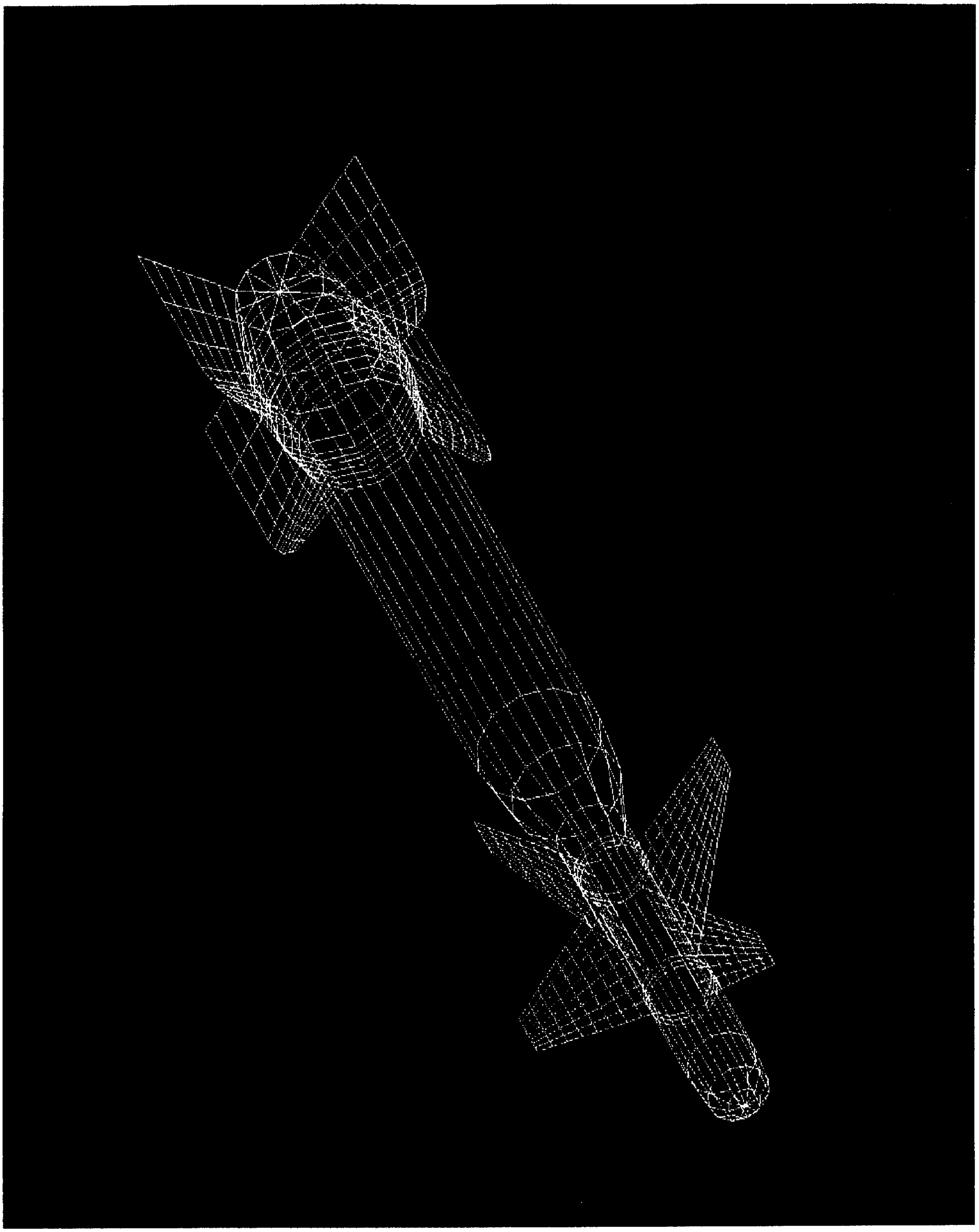

Figure 2.3 GBU-24 Geometry (Wakes not Shown)

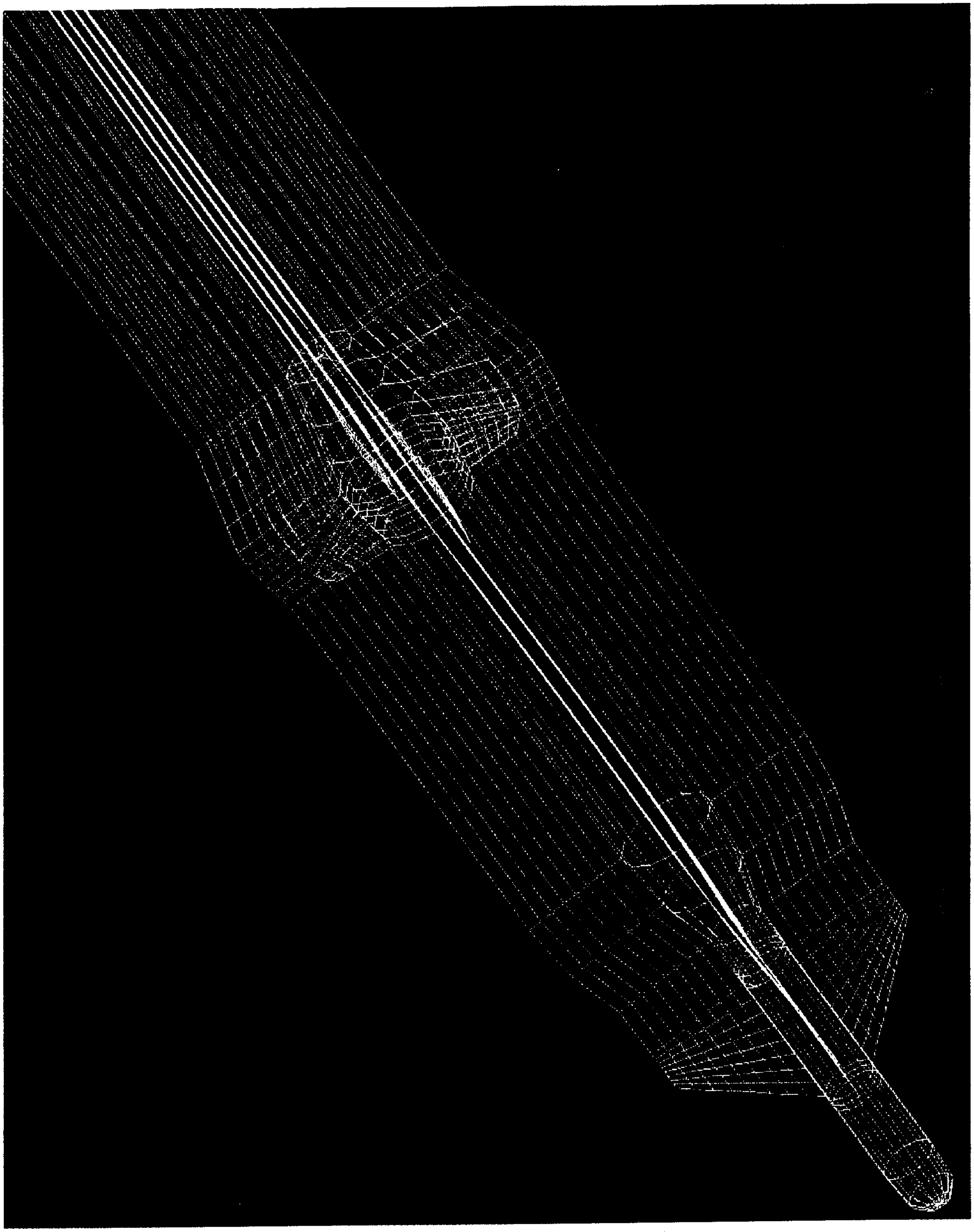

Figure 2.4 GBU-24 Geometry (Wakes Shown)

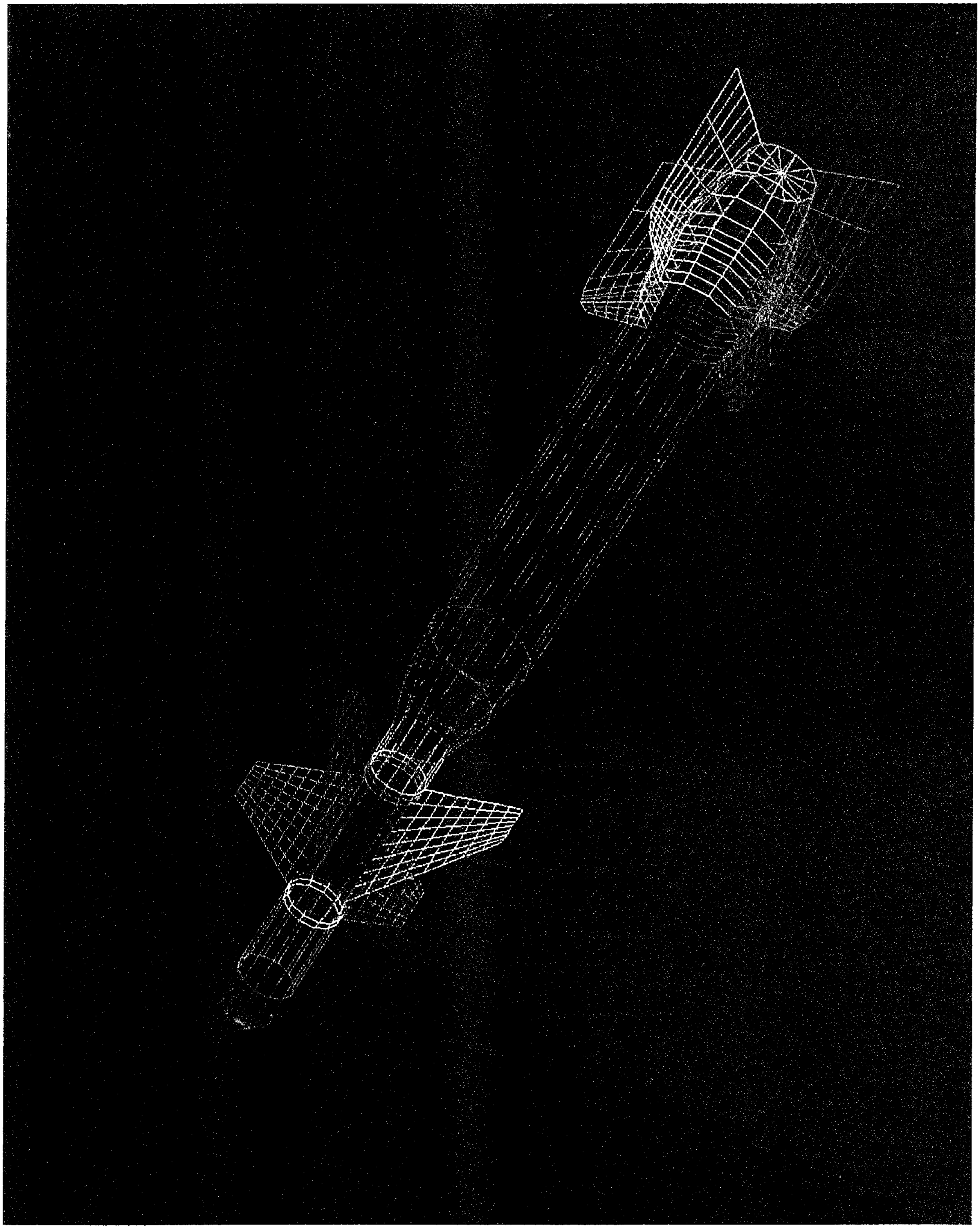

Figure 2.5 GBU-24 Geometry (Network Modelling)

because they do not abut against any physical surfaces except for the surfaces they are trailing from. The canard wakes must abut properly against the bomb's body all the way to the base. Modification of those wakes would entail modification of the entire body, or in a possible simplification, letting the wakes remain attached along the body until the base of the bomb and then shifting them relative to the free-stream.

4. The F-14

The F-14 geometry was modelled in the same fashion as the GBU-24. The geometry consists of approximately 1500 panels. While that may seem fairly coarse for such a complex structure, experience shows that it is all that is required to get accurate predictions. The primary area of interest is the underside of the fuselage forward and between the two nacelles. Higher panel density on the top half is not required. Figures 2.6 and 2.7 display the F-14 geometry without and with wakes shown. Several omissions are made to the model as having a trivial effect on the analysis or no effect at all. Phoenix rails and bomb racks are not modelled along with the chin pod because they are deemed insignificant to achieve reasonably accurate predictions over small angles of attack. External tanks were not considered, but could be modelled much in the same way as the bomb and inserted into the input file to see what effects the drop tanks have on separation forces. The vertical tails and horizontal stabilizers were deemed irrelevant to the prediction of the separation forces and were left out. This reduces the number of panels and networks, which also reduces the amount of time it takes to run a solution.

5. Combination Geometries

The F-14 and GBU-24 were modelled separately, but were combined together as shown in Figure 2.8. The first step to accomplish this was using the FORTRAN code NAVSEP which, among many of its functions will translate coordinates to relocate items in the flow-field. Once accomplished, the GBU-24 file was pasted into the F-14 input file.

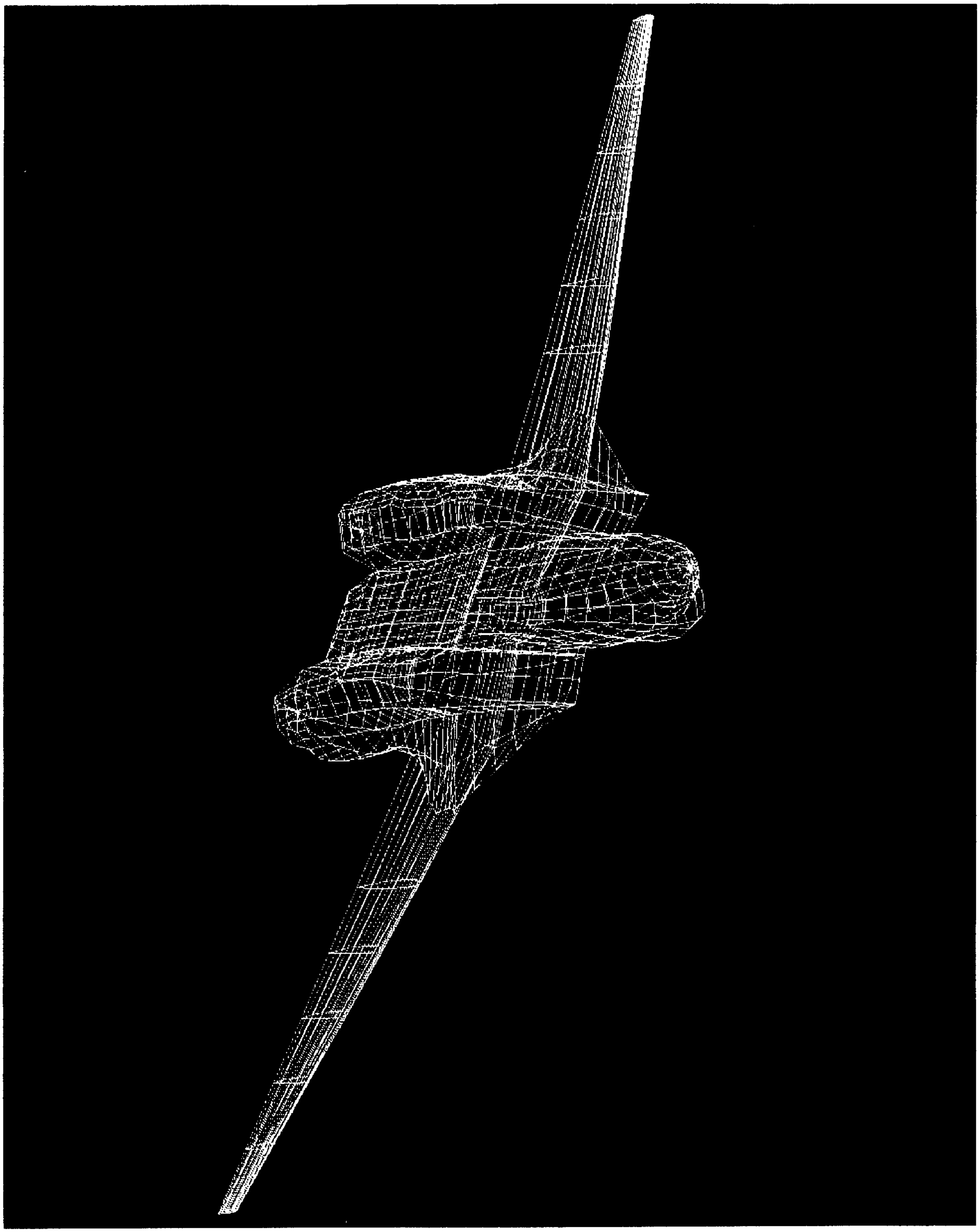

Figure 2.6 F-14 Geometry (Wakes not Shown)

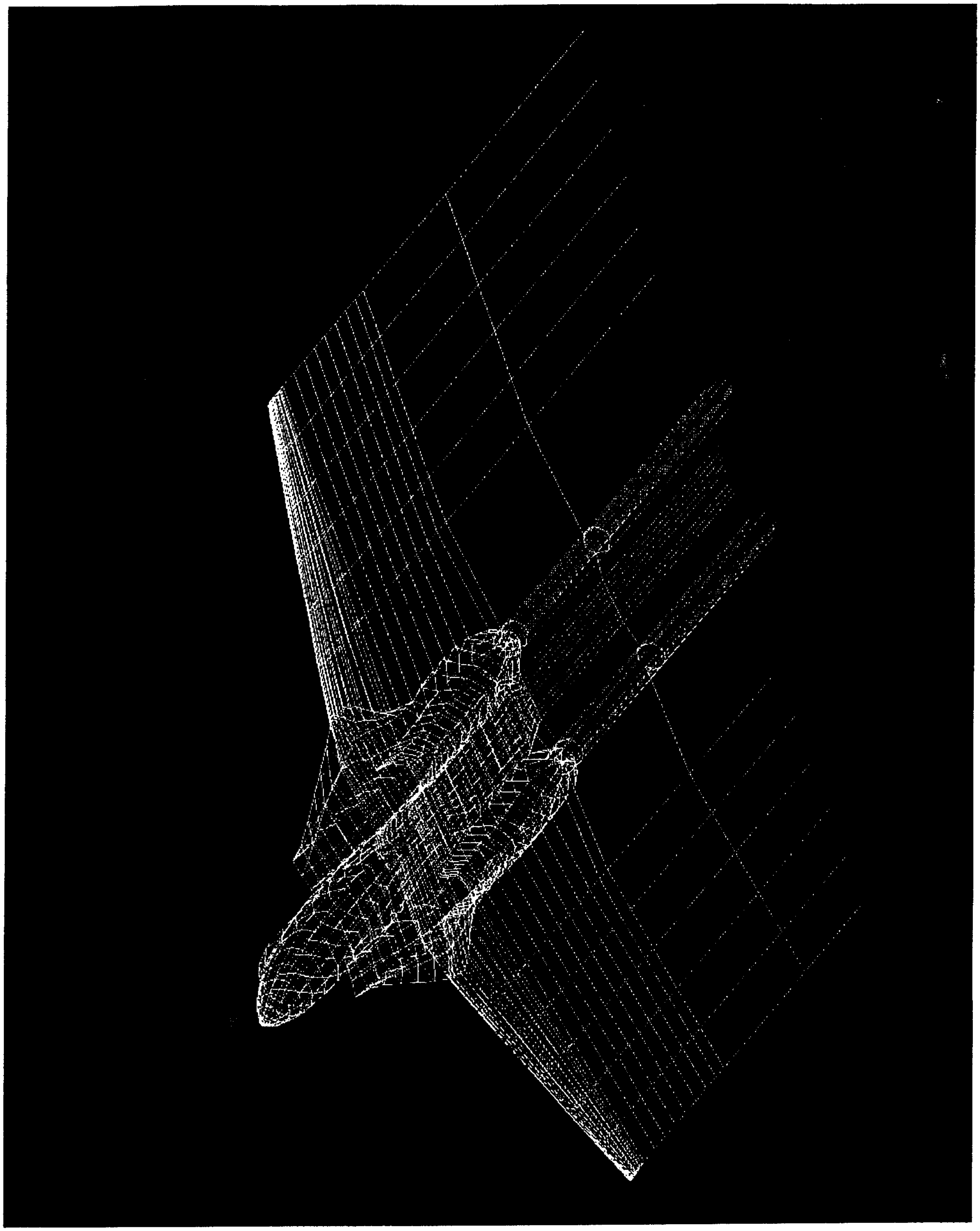

Figure 2.7 F-14 Geometry (Wakes Shown)

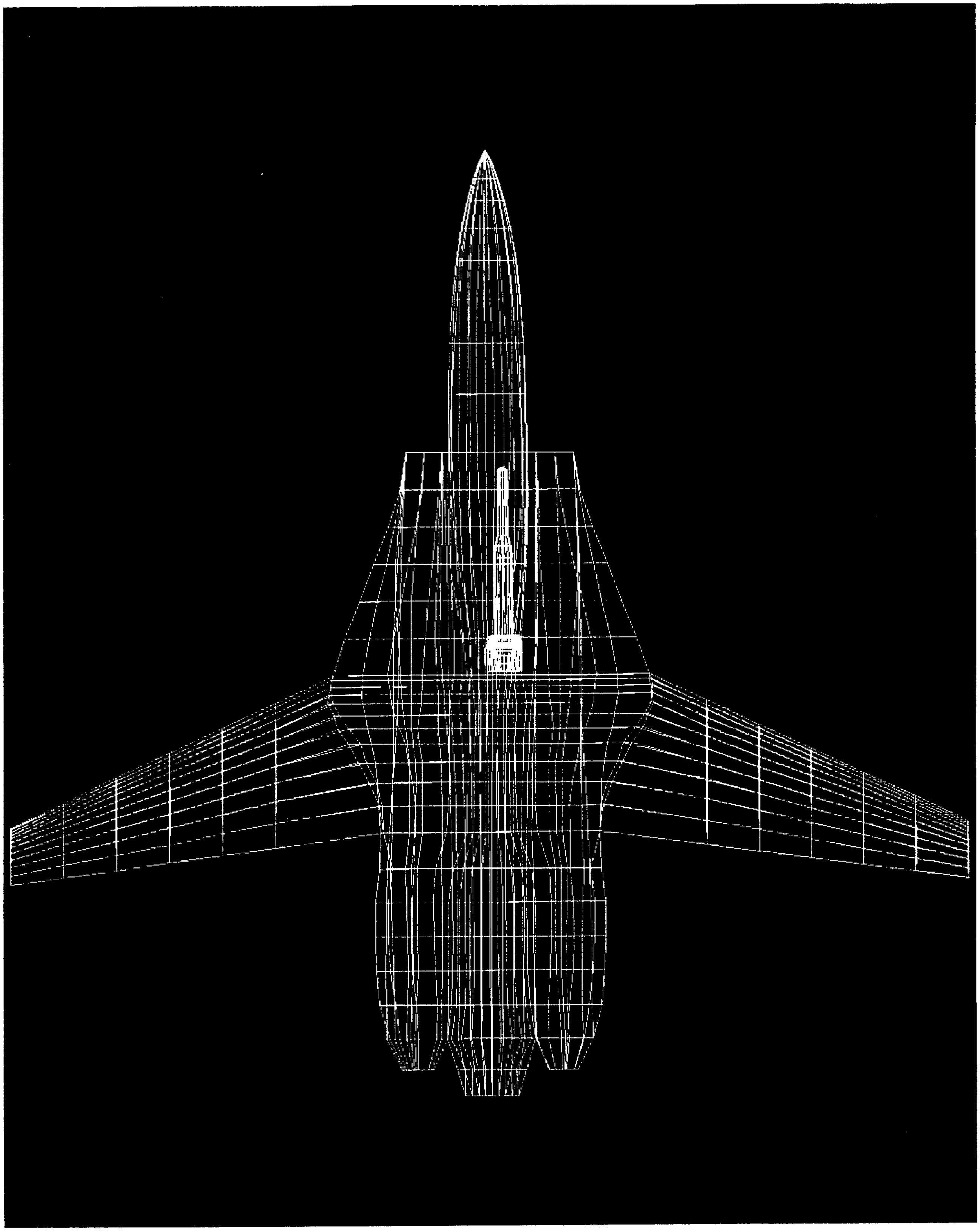

Figure 2.8 F-14 and GBU-24 on Station 3 Combined Geometries

D. GRAPHICS VISUALIZATION

One of the pre/post-processing codes that came with A502i is called RAID. Currently an executable exists in the department's computer system that can be accessed through typing after the UNIX prompt,

raid

Raid is a basic graphics program that can read A502i and TRANAIR input files and display geometries and flow properties from solutions. After accessing raid, it will ask what type of input file it is being asked to visualize. It can handle five other modes of input besides A502i/TRANAIR [Ref. 10]. It will then ask for the name of the input file. A prompt will follow asking about object definition matrices which needs to be answered by,

EACH

The next prompt will ask if the panels are going to be shaded by a Cp value. Cp is used generically in that Cp can be displayed or Mach or any of the relevant 49 surface flow properties [Ref. 4]. This is only used after a solution has been run, data has been extracted and a colorscale for contour plots has been determined. If only the geometry is to be displayed, then hit carriage return for all the next questions until a pink window appears with a menu in the lower left corner of the window. An anomaly of the program is that if you want to display the wakes, then wake display must be deselected. To view the geometry select view on the menu. All selections with the mouse in RAID are made with the center mouse button. A new window appears with a menu bar at the bottom and left and the geometry in the center. From there, rotation, translation, scaling, axes, reflections and other manipulation of the geometry is possible. Figures 2.3 through 2.8 are examples of geometries displayed on RAID.

When presentation of solutions (i.e., Cp or Mach contours) are desired, the use of another post-processing program is required to generate a colormap file. The program is

called crebar. An executable currently exists on the department's system. Type in,

crebar

after the UNIX prompt. The program will ask straightforward questions. Number values associated with colors available can be found in Ref. 10. The color file can be saved under any name, but must lie in the same directory as the input and solution files. The first line of the color file will list four numbers. The first number is the number of colors assigned to the colormap (248 maximum). Occasionally, the color bar displayed in RAID when using a colormap will disappear when certain menu items are selected. To prevent this, change the last three numbers to read 6, 1, -1. Plotting outputs from RAID requires saving the file in a format, such as RGB, that a printer will recognize. It is possible to change the text color and background color, the default is black, to avoid excessive use of black ink in hard copies.

III. DATA EXTRACTION

When a solution has run to completion, there are two files of interest, the arbitrarily named output file and the ft13 file. The arbitrarily named output file contains results for everything that A502i solves for. The ft13 file contains only the 49 surface flow properties on each panel. Appendix D is the solution portion of an arbitrarily named output file for the first network.

For purposes of displaying flow properties on RAID, it is necessary to utilize the ft13 file. A post-processing code called RAIDCONV is used to extract the specific information. To access RAIDCONV, type

raidconv

after the UNIX prompt. An executable currently exists in the department's system. The ft13 file must be in the same directory as RAIDCONV is accessed in. RAIDCONV will prompt the user for which kind of panel method is being used (A502i is one of three choices). The next prompt will ask for the name of the ft13 file. The last prompt will ask for the flow property that is to be extracted. A file called ft13.cp will be created. It can be renamed for purposes of multiple flow properties extraction. Abbreviations for the 49 flow properties can be found at the bottom of page 1 of Appendix D. The two primary flow properties are

LMACHU for local Mach number

CP2ND for second order pressure coefficient

CP2ND is the default setting for RAIDCONV. Once the ft13.cp file is created, RAID can be used as previously discussed to display the flow properties. An anomaly of RAIDCONV is that it does not recognize kt=20 type wakes, used where wakes from a wing abut against a body [Ref. 4]. To assist in extracting all the data, the kt=20 wakes

should be placed at the end of the input file. In general, it is good practice to place all wakes at the end of the input file when using A502i.

The arbitrarily named output file duplicates the data found in the ft13 file and includes moments and forces. A502i will sum up the moments and forces on each network and for all networks so far [App. D]. The moments are computed based on the coordinates entered into the input file [Ref. 4 and App. A].

IV. RESULTS OF A502i COMPUTATIONS

A. PARABOLIC ARC AIRFOIL DISCUSSION

This simple geometry was analyzed primarily to evaluate A502i's capabilities by a comparison to known linear theory. To this end, the geometry discussed in section II-C and shown in Figure 2.1 was run by A502i at a Mach of 0.3 and a Mach of 1.5 at an angle of attack of zero. Two of the 49 flow properties that A502i computes [Ref. 4] for each panel are linear Cp and second order Cp, given by

$$\text{CPLIN} = -2u_c \tag{4.1}$$

$$\text{CP2ND} = -2u_c - [(1-M_\infty^2)u_c^2 + v_c^2 + w_c^2] \tag{4.2}$$

Where u_c, v_c and w_c are the compressible components of the perturbation velocity. Figure 4.1 plots the linear theory, A502i linear and second order results for the subsonic case, while Figure 4.2 represents the supersonic solution.

Linear theory for parabolic arc airfoils is outlined in Refs. 2 and 3. The equation representing the subsonic case is given by:

$$\text{Cp(x)} = \frac{-8 * \tau_{max}}{\pi * \text{chord} * \sqrt{1 - M_\infty^2}} * (1 - (.5 - x) * \ln\left|\frac{1-x}{x}\right|) \quad \text{where } 0 < x < 1 \tag{4.3}$$

Equation 4.3 includes a Prandtl-Glauert compressibility correction. The equation representing the supersonic case is given by:

$$\begin{gathered} \text{Cp(x)} = \frac{2\theta}{\sqrt{M_\infty^2 - 1}} \quad \text{where } 0 < x < \text{chord} \\ \text{and } \theta = \tau_{max} * (\frac{1}{\text{chord}} - \frac{2x}{\text{chord}^2}) \end{gathered} \tag{4.4}$$

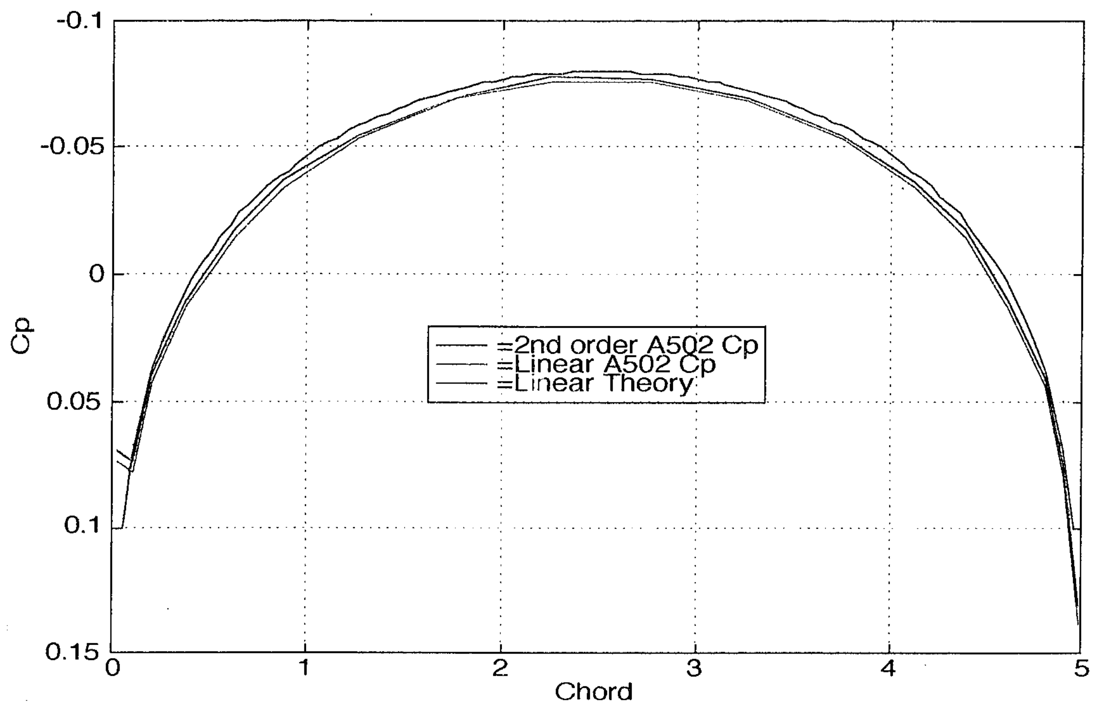

Figure 4.1 Cp Comparison of a Parabolic Arc Airfoil at Mach = 0.3.

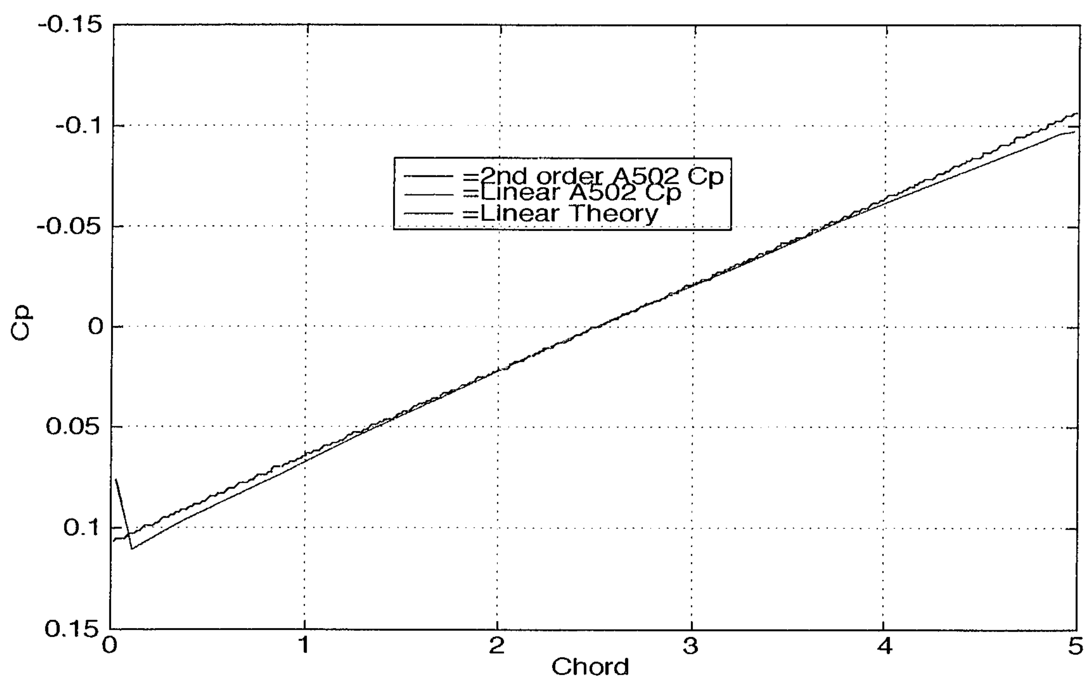

Figure 4.2 Cp Comparison of a Parabolic Arc Airfoil at Mach = 1.5.

Figure 4.1 shows very good agreement with the linear theory curve. There is a small but noticeable difference between A502i's linear results and second order results, with the second order results being more accurate, as expected. The maximum difference between the linear theory curve and the second order A502i curve amounts to a value of 2.5% right at mid-chord. The gap between the two curves from .25 chord to .75 chord were the result of thin panel density in that region.

Figure 4.2 shows excellent agreement with the linear theory curve. The A502i values of Cp for the linear and second order analysis are virtually identical. There are small deviations from linear theory near the leading and trailing edges, but this is expected due to numerical error associated with the discontinuity A502i would encounter right on the leading or trailing edges.

B. DELTAWING DISCUSSION

Reference 9 provides data on Mach distribution, using approximated linear theory, over a deltawing of the configuration discussed in section II-D. This simple geometry provided another test of A502i's capabilities. Figures 4.3 and 4.5 show the A502i results for the subsonic and supersonic case, while Figures 4.4 and 4.6 reflect the results from Ref. 9. For both cases, good agreement is found with the linear theory, with A502i's subsonic analysis being physically more accurate than the approximate linear theory, while A502i's supersonic analysis is not as physically accurate.

A comparison of Figures 4.3 and 4.4 reveals several points of interest. The Mach contour representing the free-stream value is given by the dashed line. All lines outside the dashed line represent areas where the Mach value is less than free-stream, and inside the dashed line is where the Mach value is more than free-stream. The location of where the free-stream Mach contour, in Figure 4.3, intersects the centerline agrees very well with Figure 4.4. However, Figure 4.4 does not have the contour extending all the way to the

tip. This is a physical limitation of the approximate theory used in Figure 4.4 and A502i is giving a more realistic solution. Figure 4.4 suggests that the peak Mach value occurs at approximately two-thirds chord along the centerline. The A502i results show the peak Mach contour occurring out midway along the semi-span. Those Mach values are less than 1% larger than the yellow Mach contour surrounding it, and can be attributed to how the panel density increases with movement towards the wingtip. A502i performed very well for this subsonic case.

A comparison of Figures 4.5 and 4.6 shows that A502i did not perform as well as in the subsonic case. Again, the contour representing the free-stream value of Mach =1.414 is given by the dashed line. All lines forward are below free-stream and all lines aft are above free-stream. Figure 4.6 shows the intersection of the free-stream Mach contour on the centerline occurring at approximately 39% chord, which is in excellent agreement with A502i's result. Figure 4.6 shows the peak Mach value occurring at the trailing edge on the centerline. This makes more physical sense than the results that A502i yielded. The maximum thickness of the deltawing occurs along the centerline, allowing for greater expansion. The discrepancy may be attributable to panel density and accumulation of numerical error. A close study of the A502i results reveals some discontinuities along the column of panels out at the wing-tip which would have adversely affected the solution and caused errors to propagate along the semi-span.

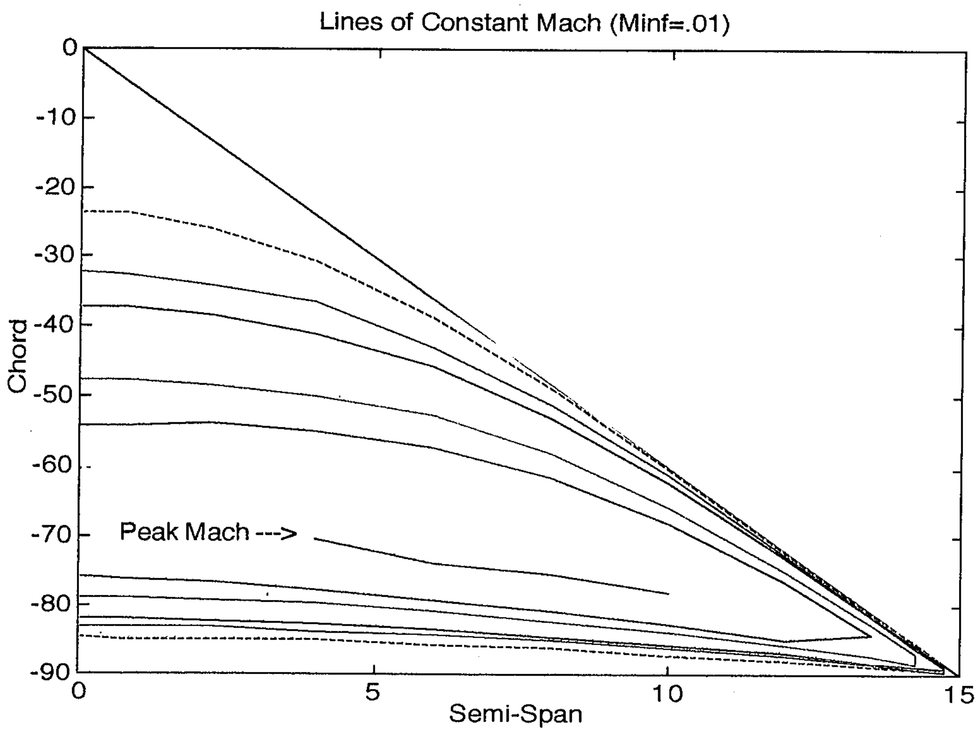

Figure 4.3 A502i Mach Contour Plot (M_∞=.01)

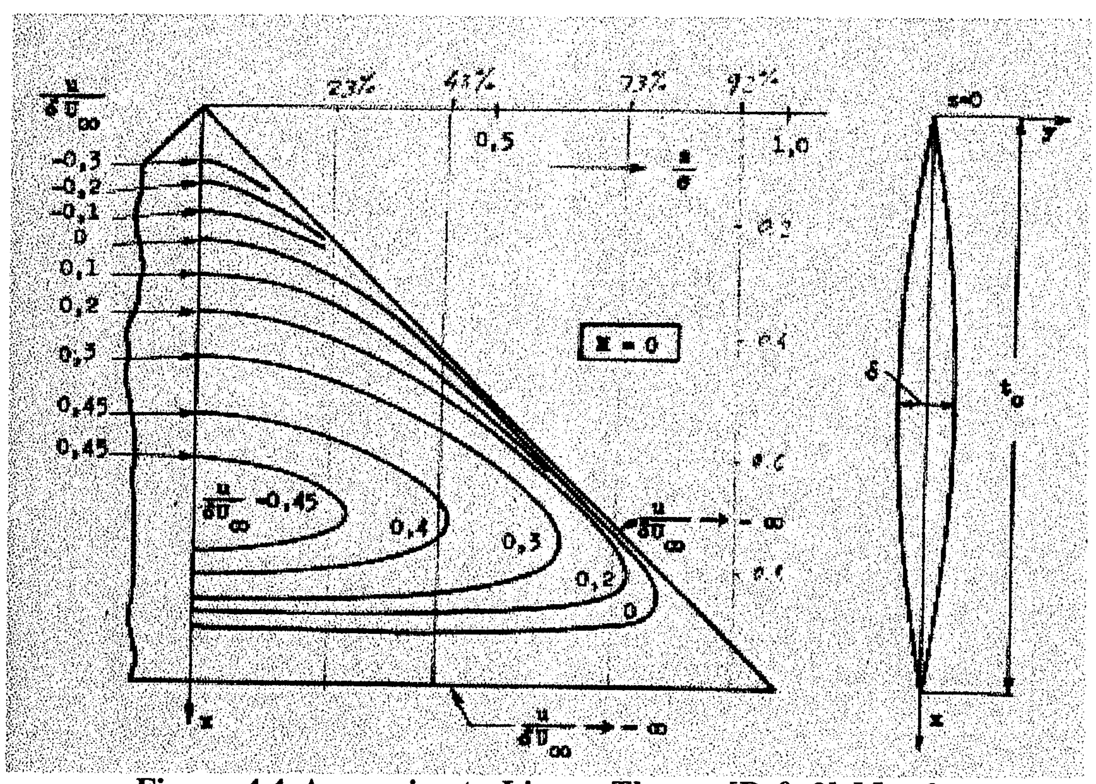

Figure 4.4 Approximate Linear Theory [Ref. 9] M_∞=0

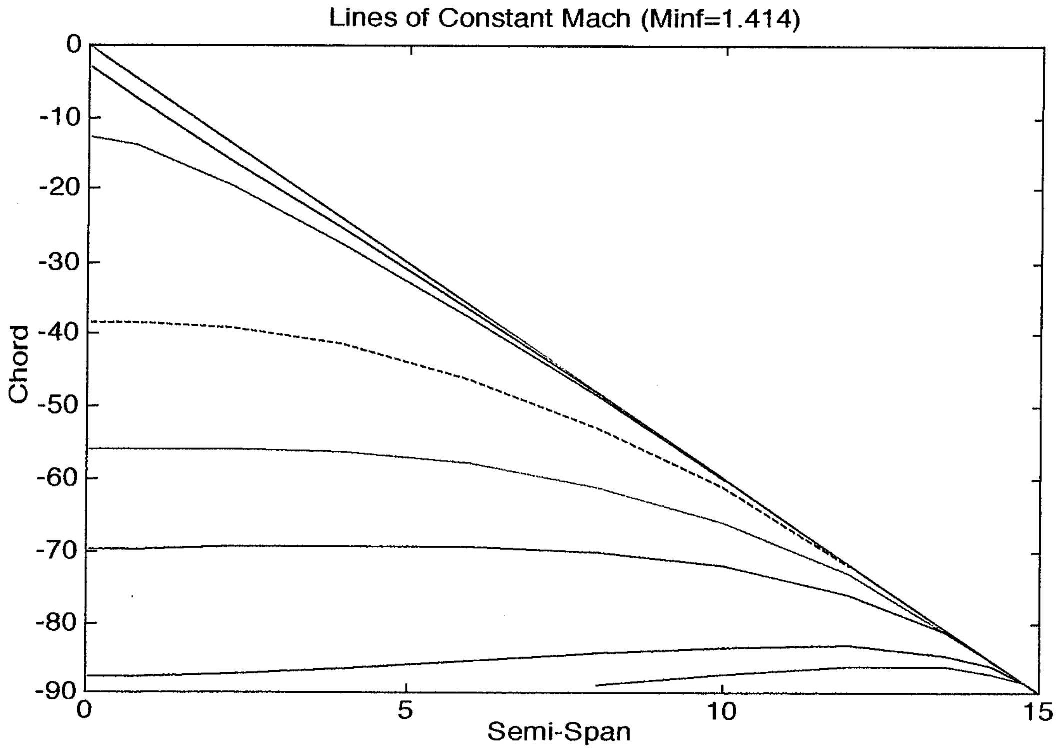

Figure 4.5 A502i Mach Contour Plot (M_∞=1.414)

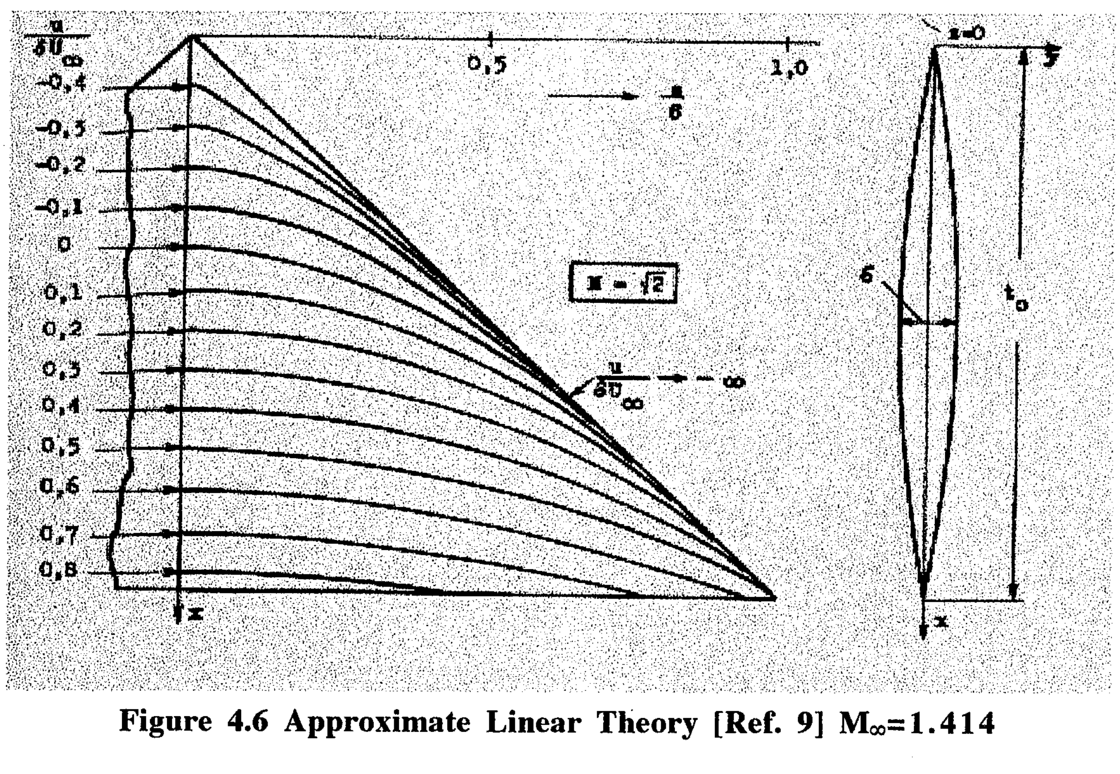

Figure 4.6 Approximate Linear Theory [Ref. 9] M_∞=1.414

C. GBU-24 FREE-STREAM (NO CANARDS) DISCUSSION

A free-stream measurement of separation forces on the GBU-24, without canards, was conducted in a wind tunnel for various Mach numbers from .8 to 1.2 [Ref. 7]. Since A502i uses linear potential theory, the model of the GBU-24, without canards, was evaluated at both Mach .8 and 1.2, avoiding the transonic regime, to ascertain the accuracy of the code with the given geometry. Normal forces and pitching moments for both cases are plotted and compared to the wind tunnel data.

1. Subsonic Case (M_∞=0.8)

The GBU-24 model, without the canards, was run for angles of attack varying from -10 to +10 degrees in two degree increments. Values much higher than that ran into wake modelling problems as the wake's angle relative to the free-stream was getting large enough that results would become questionable, and remodelling the wake was too difficult for such a complex geometry. The results of the A502i analysis are displayed in Figures 4.7 and 4.8. For angles of attack between -4 and +4 degrees, A502i does a good job of predicting the separation forces. The pitching moment, which happens to be unstable without the canards, is approximately linear over the -4 to +4 degree range and is the limiting factor to the models accuracy. The normal force is approximately linear over a wider range, and A502i does a good job of predicting the normal forces from -6 to +6 degrees.

2. Supersonic Case (M_∞=1.2)

The results for the subsonic case demonstrated that the effective range of angle of attack that A502i needed to explore was from -6 to +6 degrees. Figures 4.9 and 4.10 plot the comparison of wind tunnel data versus A502i results for pitching moment and normal force. The results for the supersonic case are slightly better than that of the subsonic case. The actual pitching moment of the GBU-24 is approximately linear over a wider angle of

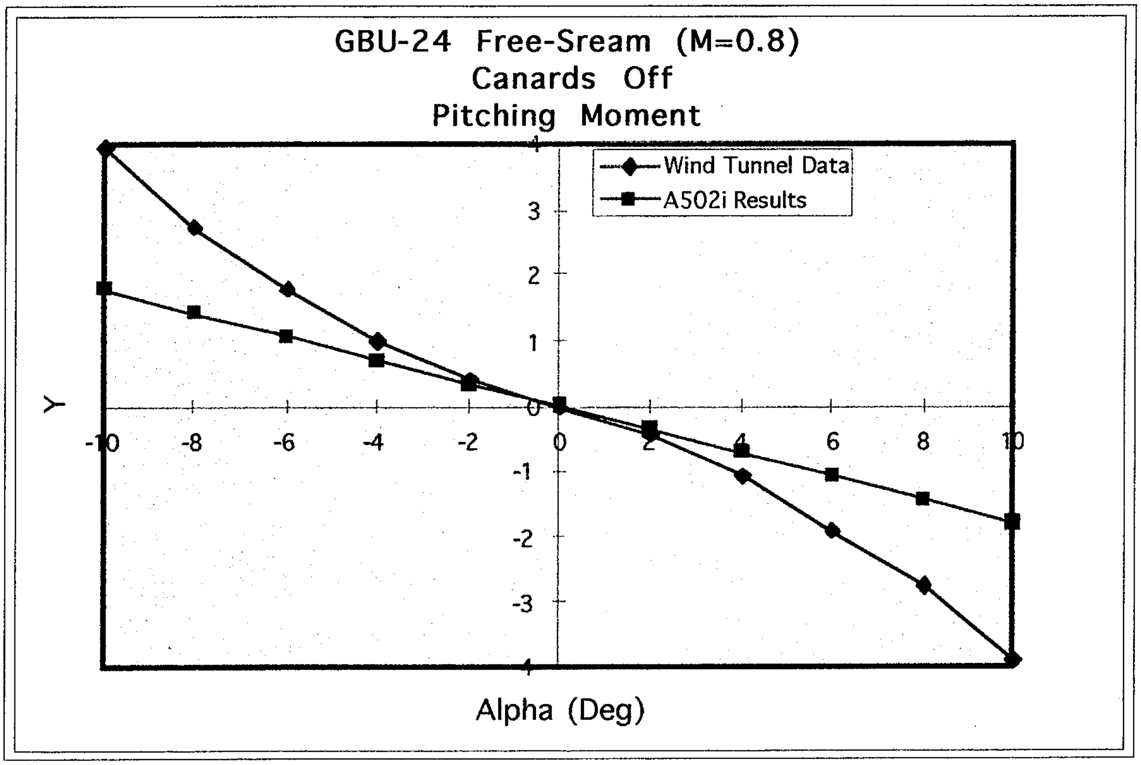

Figure 4.7 Comparison of Pitching Moments

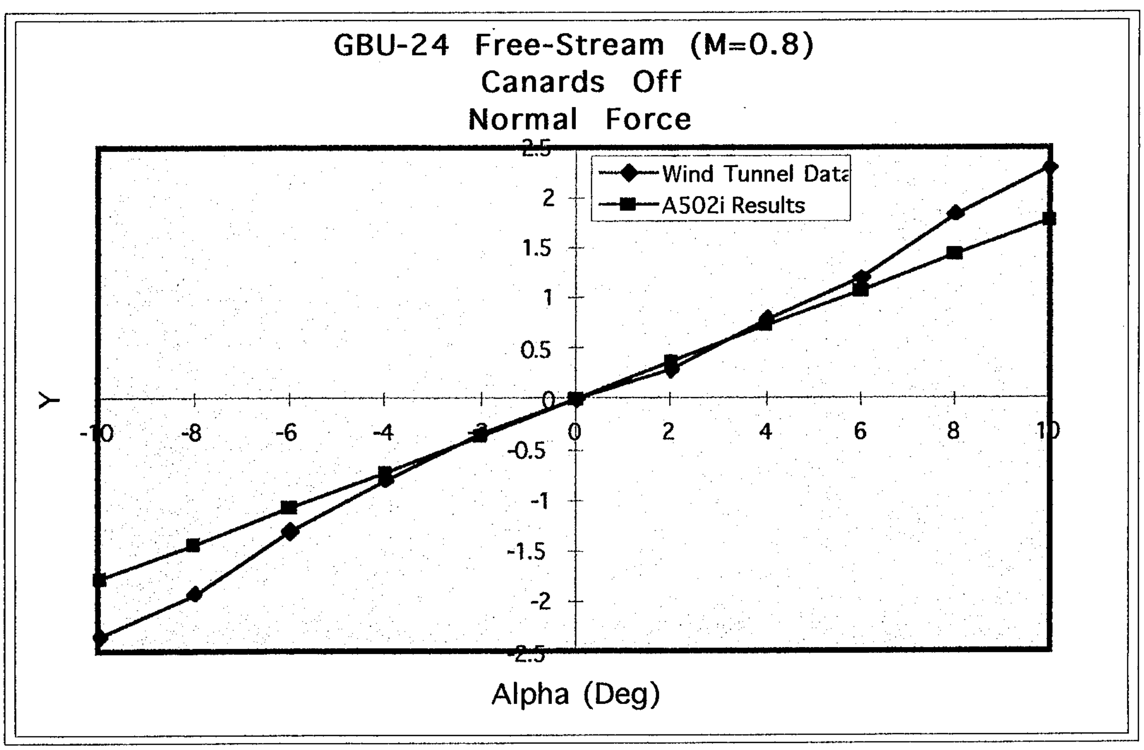

Figure 4.8 Comparison of Normal Forces

attack region, but fluctuations in the data at -6 and +6 degrees means that the model is still only viable from -4 to +4 degrees. The normal force line is nearly linear from -10 to +10 degrees and extrapolating the A502i results out to 10 degrees would still yield good predictions.

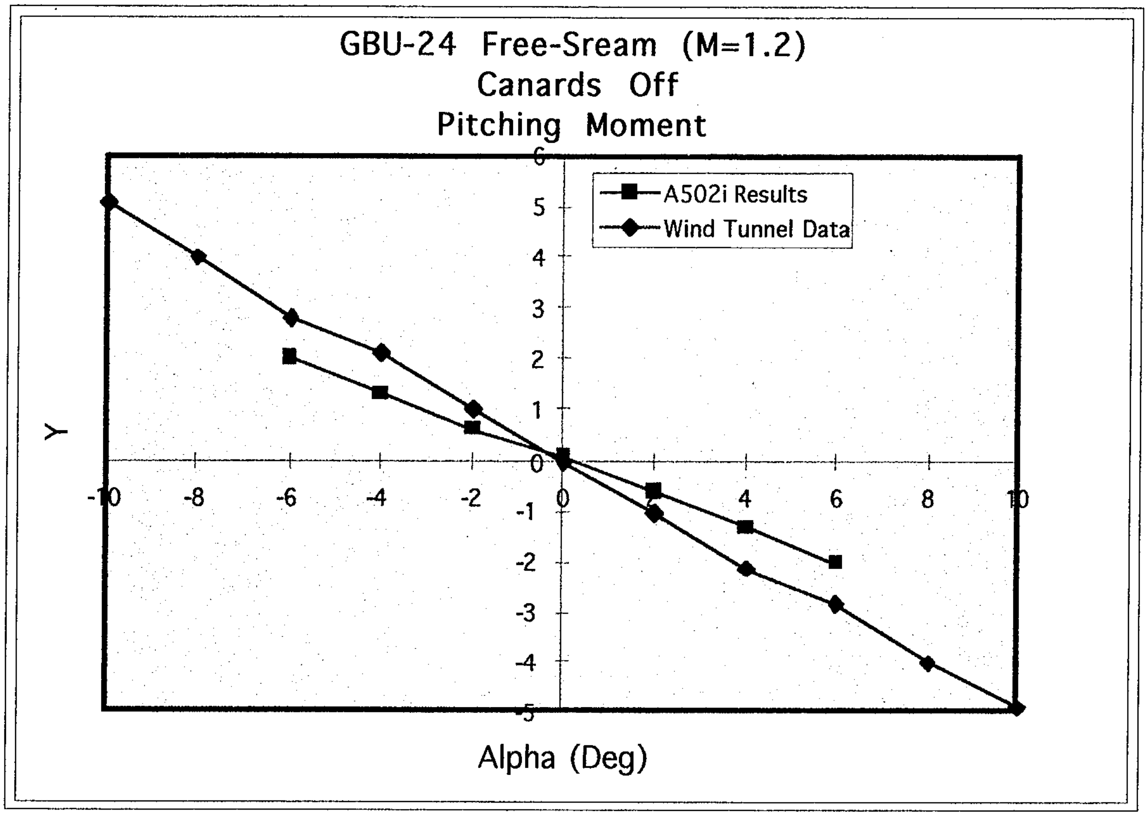

Figure 4.9 Comparison of Pitching Moments

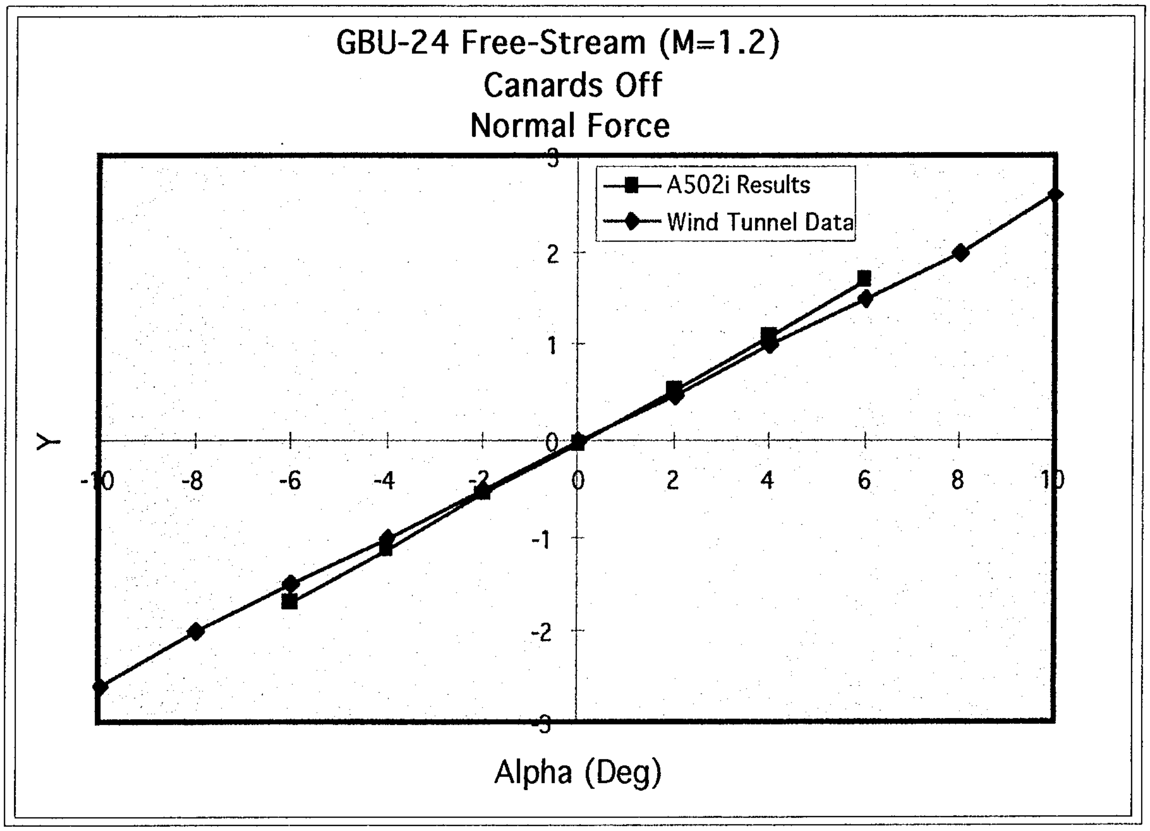

Figure 4.10 Comparison of Normal Forces

D. GBU-24 FREE-STREAM (WITH CANARDS) DISCUSSION

As in the case with no canards, free-stream measurements of the separation forces on GBU-24 were taken from Mach .8 to 1.2 in a wind tunnel [Ref. 7]. Again, due to the limitations of linear theory inherent in the code, an analysis was done for Mach numbers of .8 and 1.2 to minimize transonic effects. Even with the more complex geometry, A502i does an accurate job of predicting the separation forces over the range of angles of attack that are approximately linear.

1. Subsonic Case (M_∞=0.8)

The GBU-24 model, with canards, was run in two degree increments of angle of attack from -10 to +10. The wake modelling limitation, as well as reviewing the data from the wind tunnel measurements [Ref. 7] showed the non-linearity of the separation forces at

the higher values of angle of attack, precluded any attempts to predict forces beyond the aforementioned angle of attack interval. The results of the A502i analysis are displayed in Figures 4.11 and 4.12. The addition of the canards makes the pitching moment stable, but linear over a smaller region than without the canards. A502i gave accurate results from -2 to +2 degrees angle of attack when predicting pitching moment. The prediction of normal forces fared better, showing accurate results from -3 to +3 degrees angle of attack.

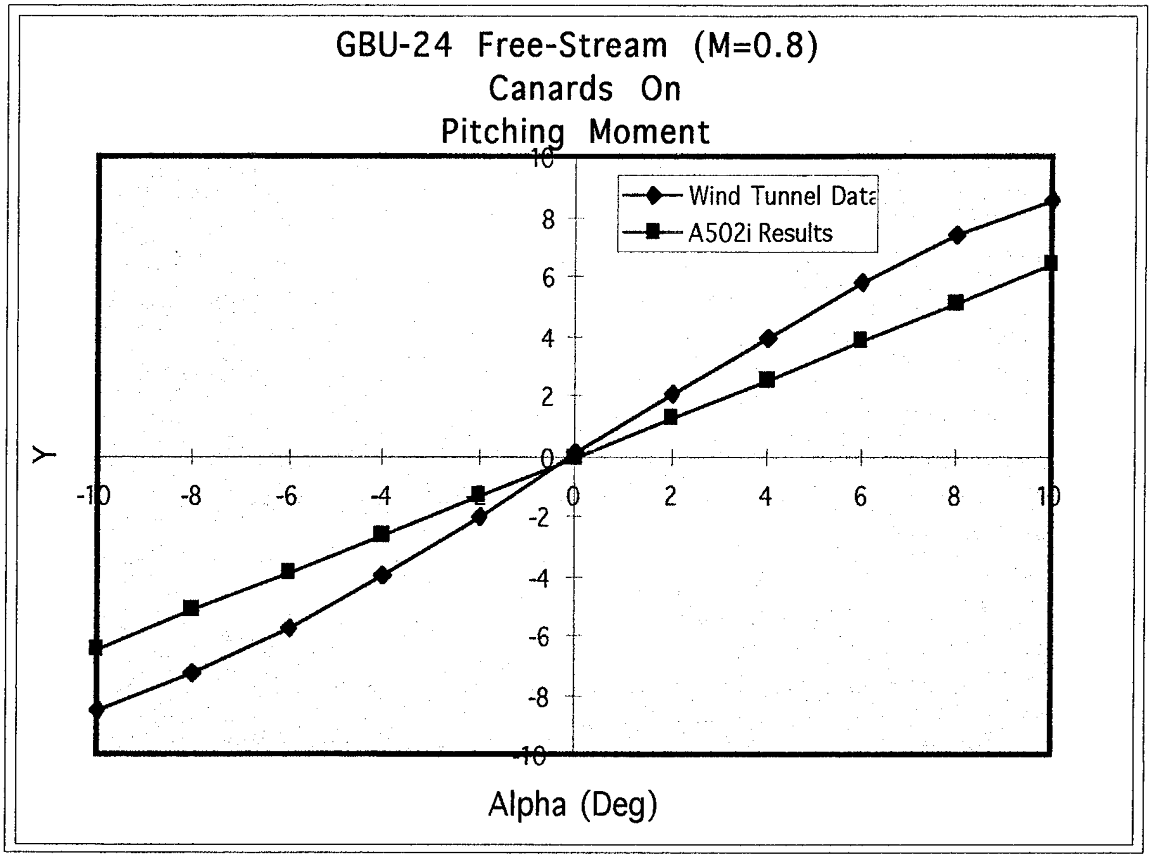

Figure 4.11 Comparison of Pitching Moments

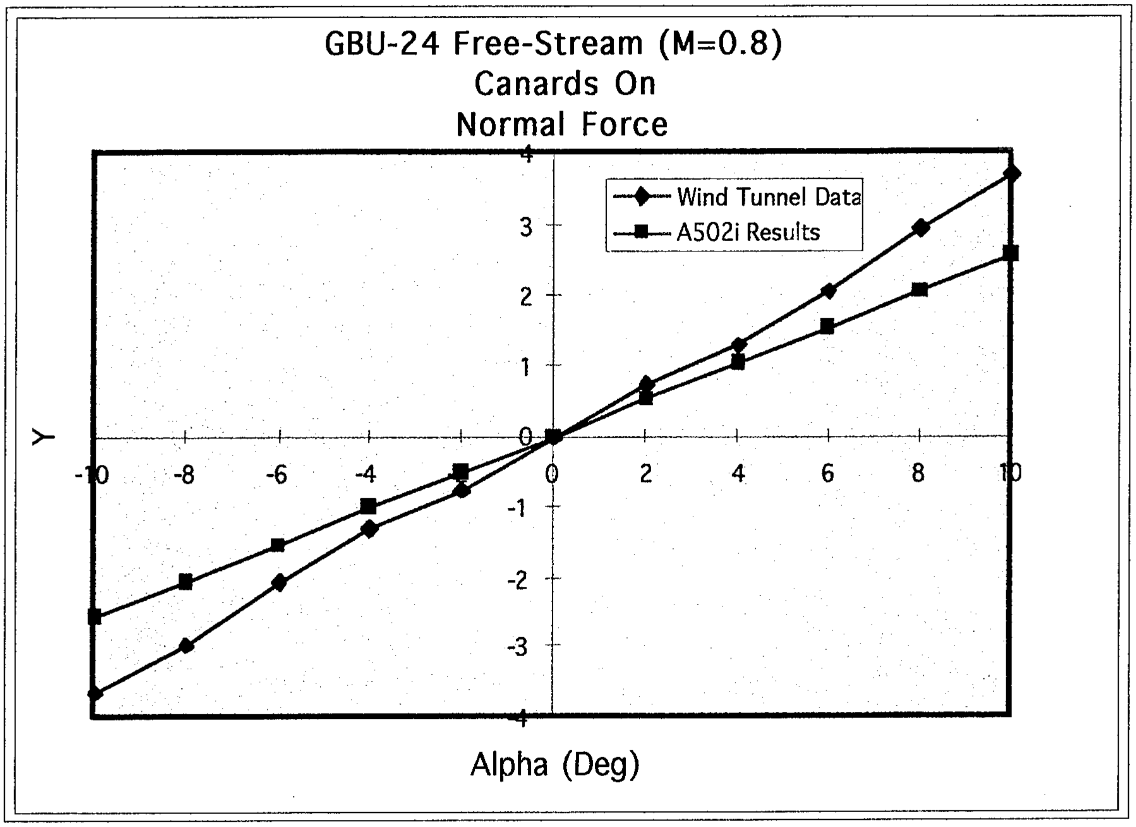

Figure 4.12 Comparison of Normal Forces

2. Supersonic Case (M_∞=1.2)

As in the case with no canards, the region of accuracy, with the model used, was assumed to be less than + or - 10 degrees angle of attack. Cases were run from -6 to +6 degrees angle of attack in two degree increments. A comparison of A502i results with wind tunnel data is shown in Figures 4.13 and 4.14. For both the pitching moment and the normal force, A502i does a much better job of prediction then when subsonic. The wind tunnel data is nearly linear in both pitch moment and normal force from -8 to +8 degrees angle of attack. Extrapolating the A502i data out to + or - 8 degrees angle of attack, shows excellent agreement with the wind tunnel data.

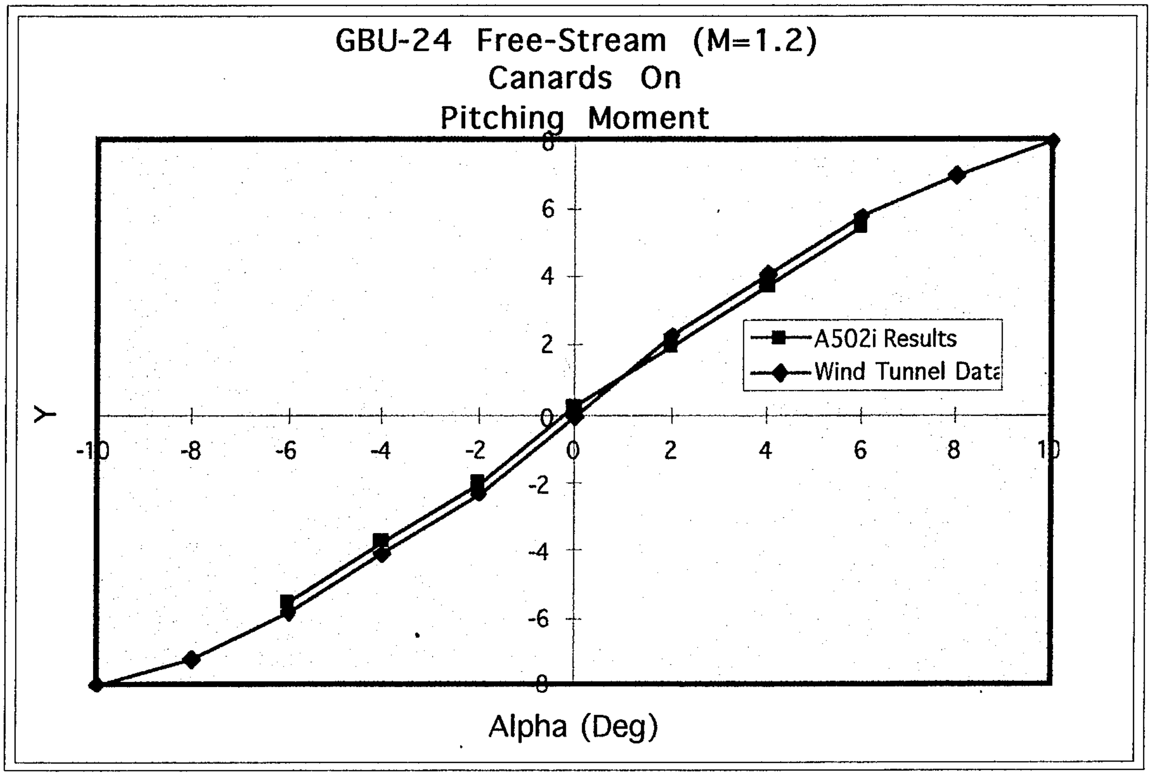

Figure 4.13 Comparison of Pitching Moments

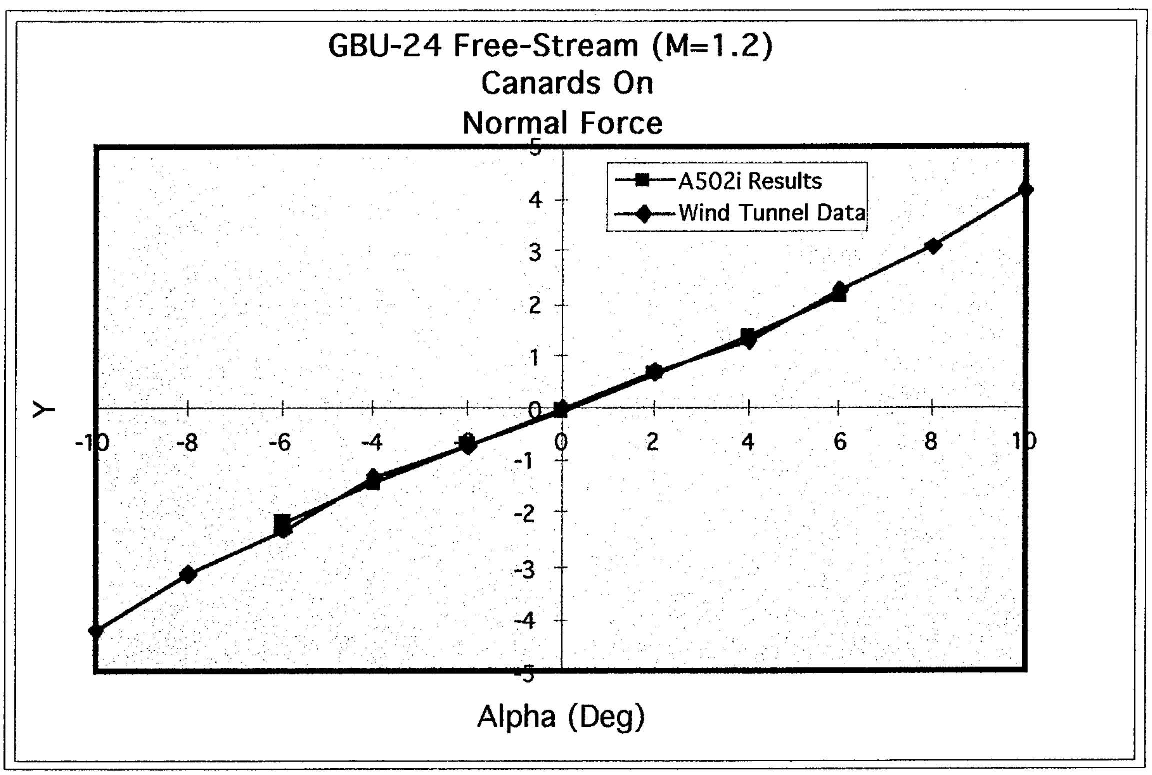

Figure 4.14 Comparison of Normal Forces

E. F-14 DISCUSSION

The GBU-24, without canards was located at station 3 of the F-14 via the NAVSEP code. In the process of running a solution, the combined geometries were found to have a total of 150 networks (A502i's maximum). The combined geometry had about 4,000 panels, far short of the 20,000 panel maximum, so there was room for more detailed modelling, but there was not a chance to insert the GBU-24, with canards, into the F-14's flow field and analyze the forces on the bomb. The geometry with the canardless bomb ran to a solution that appeared to be valid, so there is a high degree of confidence that if the number of networks could be reduced to allow the GBU-24, with canards, to be inserted into the F-14 flow field, the code would yield accurate predictions at small angles of attack on the forward stations. To reduce the total number of networks by combining existing networks would have required a large time investment and the use of MACGS, which the department currently does not possess, the two reasons why it was not done. Figure 4.15 shows a Mach distribution of the solution of the canardless bomb and F-14 at Mach = 0.8 and 0 degrees angle of attack

F. POST-PROCESSING DISCUSSION

The Mach values for the subsonic case of the GBU-24, with canards, at 4 degrees angle of attack, were extracted from the ft13 file. These values, used in conjunction with RAID are shown in Figures 4.16 and 4.17. The color distribution over the nose in Figure 4.16 indicates that the bomb is at an angle of attack, and scanning the rest of the model showed no discontinuous solutions, which is generally represented in A502i by a Mach value of 0 or 1,000. The visual representation is a quick way of telling if A502i ran an accurate solution. The only other way is to individually check the Mach or Cp values of each panel in the ft13 file or the arbitrarily named output file. The other point of interest in Figure 4.16 is the lack of panel density along the mid-section of the bomb. The goal, in the

case of stores separation prediction, is to have as simple a model as possible that still gives accurate predictions. The fewer the number of panels, the shorter the run time. The fact that A502i is a higher order panel method allows the luxury of using fewer panels. Figure 4.17 highlights the approach used to take into account separation effects as discussed on page 16.

Figure 4.15 Mach Distribution over GBU-24 and F-14 (M_∞=0.8, alpha=0°)

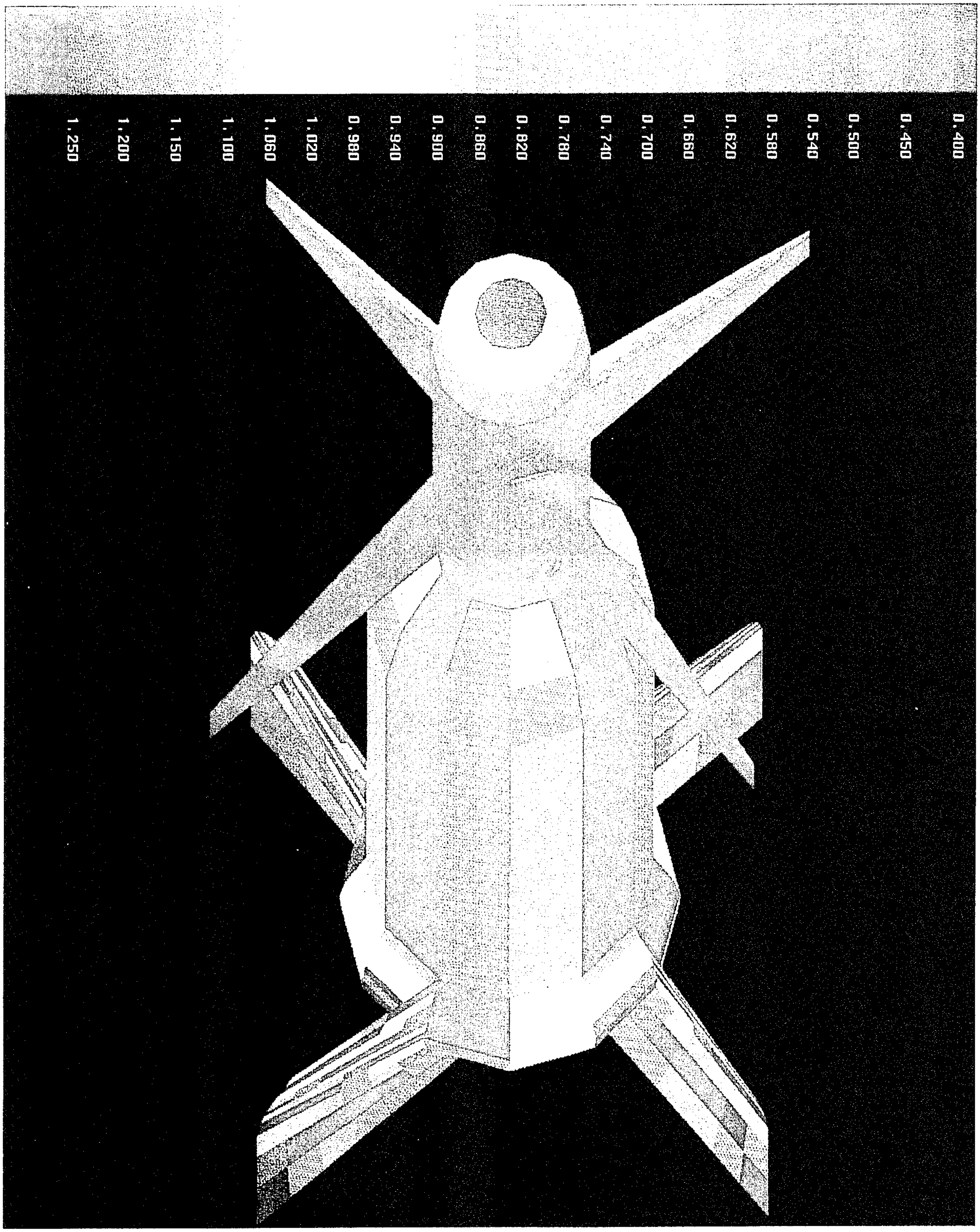

Figure 4.16 Mach Distribution over GBU-24 (M_∞=0.8, alpha=4°)

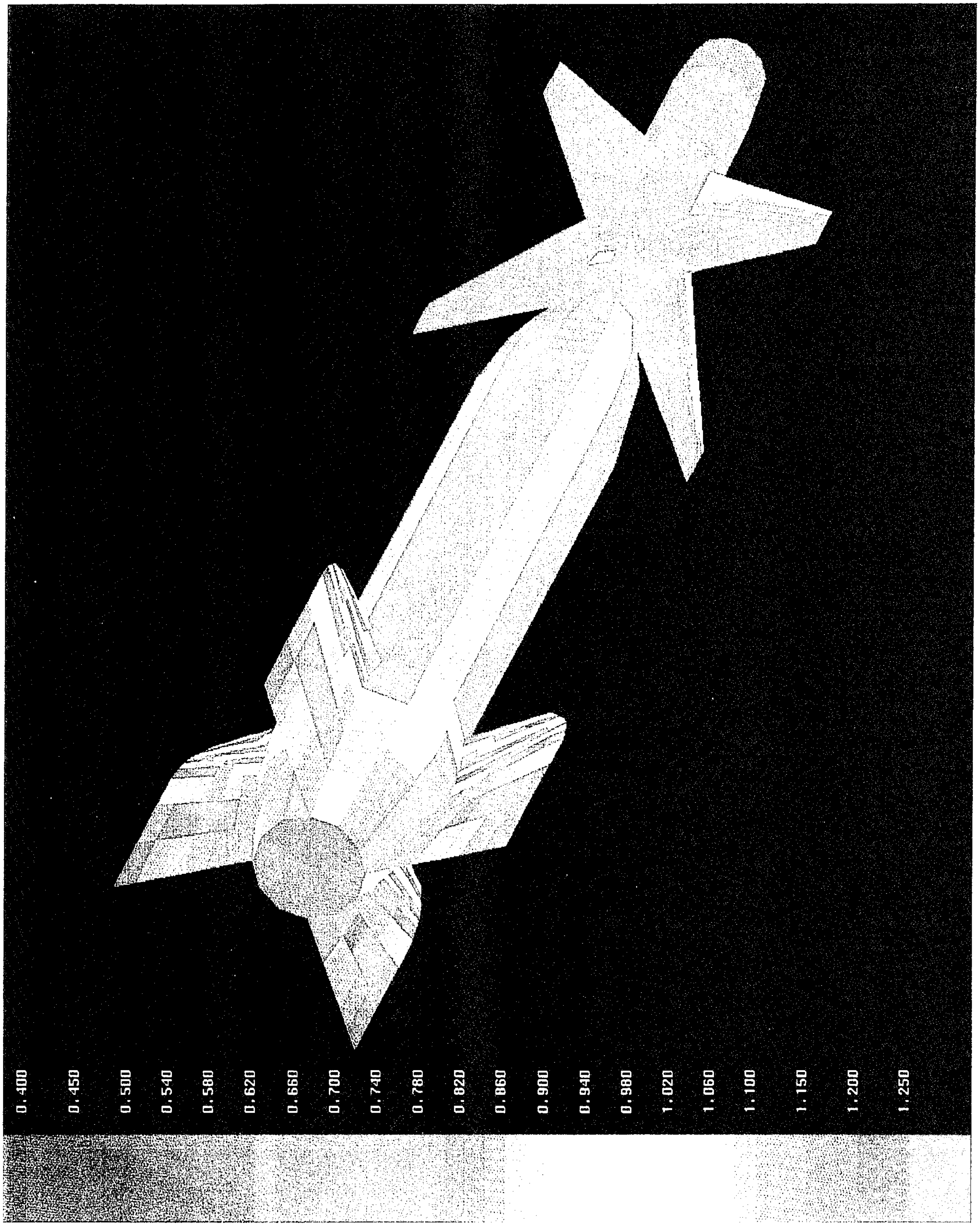

Figure 4.17 Mach Distribution over GBU-24 (M_∞=0.8, alpha=4°)

V. SUMMARY AND CONCLUSIONS

The main goal of this analysis is to determine the accuracy of A502i on both simple geometries and complex geometries. To accomplish this, A502i is compared with results available from linear theory and wind tunnel experiments. This allows conclusions to be drawn on the capabilities as well as the limitations of A502i.

In general, A502i can accurately predict flow properties, forces and moments on simple and complex geometries at low angles of attack. The predictions are valid over a wide Mach range, from 0 up to and including 0.8 and from 1.2 and above. The supersonic solutions are available due to A502i's higher order capabilities.

The limitations of A502i are consistent with most panel methods. A502i cannot predict flow dominated by viscous, separated or transonic effects. It cannot predict flow with different total pressures, such as flow properties inside a jet plume or a propeller slipstream swirl. The biggest shortcoming of A502i is its inability to handle unsteady cases and automatically determine wake shapes.

Experience or knowledge of the flow properties around the geometry being tested is important in building an accurate model. An accurate model may not be physically accurate. Flight test results revealed a yawing moment on the GBU-24 that was not discovered in wind tunnel experiments when the bomb was carried on an aft station. The yawing moment may be caused by the fact that the canards are not fixed, but spring-damped. A502i predictions would not be accurate without inputting a moment to simulate the deflection of the canards, since the canards are fixed by the geometry. A502i, while a powerful tool in terms of cost savings and time, cannot completely substitute for wind tunnel experiments and flight tests, as constructing a complex geometry to exact physical specifications will probably not yield accurate predictions.

APPENDIX A. GBU-24 OUPUT FILE (INPUT FILE PORTION)

Printed by maletour from osprey

```
Mar 7 1996 13:51                          results                          Page 1

 ******************************************************************************************

   dynamic memory management initialization

   max no. levels         15   max no. arrays        200   maximum scratch storage     900000   total storage provided  900000
     addr(maplev)          0     addr(maplws)          0     addr(scratch storage)          1

 ******************************************************************************************
  wopen call on unit    1  blocks:    10   status:     0
  wopen call on unit    2  blocks:    10   status:     0
  wopen call on unit    3  blocks:    10   status:     0
1

 **********************************************************************
 *                                                                    *
 *                    a502 - pan-air technology program               *
 *                                                                    *
 *              potential flow about arbitrary configurations         *
 *              version id = ht2 (12 feb 92) boeing ver i00           *
 *                                                                    *
 *                              07-Mar-9                              *
 *                                                                    *
 *                                                                    *
 * GBU-24 FREESTREAM M=0.8
 * $SOLUTION
 *                                                                    *
 *                                                                    *
 *                                                                    *
 **********************************************************************
1
0*b*input-da




                     - list of a502 input data cards -
     1 $TITLE
     2 GBU-24 FREESTREAM M=0.8
     3 $SOLUTION
     4 $SYMMETRY
     5 = MISYMM   MJSYMM
     6 0.         0.
     7 $MACH NUMBER
     8 =AMACH
     9 .8
    10 $CASES
    11 =NCASE
    12 1.
    13 $ANGLES-OF-ATTACK
    14 =ALPC
    15 2.
    16 =ALPHA(1)
```

1

```
2.
$PRINTOUT OPTIONS
=ISINGS    IGEOMP    ISINGP    ICONTP    IBCONP    IEDGEP
0.         0.        0.        1.        0.        0.
=IPRAIC    NEXDGN    IOUTPR    IFMCPR
0.         0.        0.        0.
$REFERENCES FOR ACCUMULATED FORCES AND MOMENTS
=XREF      YREF      ZREF      NREF
100.716    0.0       0.0       1.
=SREF      BREF      CREF      DREF
165.1248   1.0       14.496    14.496
$POINTS NETWORK =     ZCAN4
1.0
2.0
         9.0        9.0
      45.236      3.138     -2.324     42.548      3.138     -2.324
      39.859      3.138     -2.324     37.171      3.138     -2.324
      34.483      3.138     -2.324     31.795      3.138     -2.324
      29.107      3.138     -2.324     26.418      3.138     -2.324
      23.730      3.138     -2.324
      45.183      4.642     -3.583     42.732      4.642     -3.582
      40.281      4.642     -3.582     37.830      4.642     -3.582
      35.380      4.642     -3.581     32.929      4.642     -3.581
      30.478      4.642     -3.581     28.027      4.642     -3.580
      25.576      4.642     -3.580
      45.130      6.146     -4.841     42.917      6.146     -4.840
      40.703      6.146     -4.840     38.489      6.146     -4.839
      36.276      6.146     -4.839     34.063      6.146     -4.838
      31.849      6.146     -4.837     29.635      6.146     -4.837
      27.422      6.145     -4.836
      45.077      7.650     -6.100     43.101      7.650     -6.099
      41.125      7.650     -6.098     39.149      7.650     -6.097
      37.173      7.650     -6.096     35.196      7.650     -6.095
      33.220      7.650     -6.094     31.244      7.649     -6.093
      29.268      7.649     -6.092
      45.025      9.155     -7.358     43.286      9.155     -7.357
      41.547      9.154     -7.355     39.808      9.154     -7.354
      38.069      9.154     -7.353     36.330      9.154     -7.352
      34.591      9.153     -7.350     32.853      9.153     -7.349
      31.114      9.153     -7.348
      44.972     10.659     -8.616     43.470     10.659     -8.615
      41.969     10.659     -8.613     40.467     10.658     -8.612
      38.966     10.658     -8.610     37.464     10.658     -8.608
      35.963     10.658     -8.607     34.461     10.657     -8.605
      32.959     10.657     -8.603
      44.919     12.163     -9.875     43.655     12.163     -9.873
      42.390     12.163     -9.871     41.126     12.162     -9.869
      39.862     12.162     -9.867     38.598     12.162     -9.865
      37.334     12.161     -9.863     36.069     12.161     -9.861
      34.805     12.161     -9.859
      44.866     13.668    -11.133     43.839     13.667    -11.131
      42.812     13.667    -11.129     41.785     13.667    -11.127
      40.759     13.666    -11.124     39.732     13.666    -11.122
      38.705     13.665    -11.120     37.678     13.665    -11.117
      36.651     13.665    -11.115
      44.813     15.172    -12.392     44.024     15.172    -12.389
      43.234     15.171    -12.387     42.445     15.171    -12.384
```

```
   41.655    15.170   -12.381    40.866    15.170   -12.379
   40.076    15.169   -12.376    39.287    15.169   -12.374
   38.497    15.168   -12.371
$POINTS NETWORK =    ZCAN3
1.0
2.0
      9.0       9.0
   45.236    -2.324    -3.138    42.548    -2.324    -3.138
   39.859    -2.324    -3.138    37.171    -2.324    -3.138
   34.483    -2.324    -3.138    31.795    -2.324    -3.138
   29.107    -2.324    -3.138    26.418    -2.324    -3.138
   23.730    -2.324    -3.138
   45.183    -3.583    -4.642    42.732    -3.582    -4.642
   40.281    -3.582    -4.642    37.830    -3.582    -4.642
   35.380    -3.581    -4.642    32.929    -3.581    -4.642
   30.478    -3.581    -4.642    28.027    -3.580    -4.642
   25.576    -3.580    -4.642
   45.130    -4.841    -6.146    42.917    -4.840    -6.146
   40.703    -4.840    -6.146    38.489    -4.839    -6.146
   36.276    -4.839    -6.146    34.063    -4.838    -6.146
   31.849    -4.837    -6.146    29.635    -4.837    -6.146
   27.422    -4.836    -6.145
   45.077    -6.100    -7.650    43.101    -6.099    -7.650
   41.125    -6.098    -7.650    39.149    -6.097    -7.650
   37.173    -6.096    -7.650    35.196    -6.095    -7.650
   33.220    -6.094    -7.650    31.244    -6.093    -7.649
   29.268    -6.092    -7.649
   45.025    -7.358    -9.155    43.286    -7.357    -9.155
   41.547    -7.355    -9.154    39.808    -7.354    -9.154
   38.069    -7.353    -9.154    36.330    -7.352    -9.154
   34.591    -7.350    -9.153    32.853    -7.349    -9.153
   31.114    -7.348    -9.153
   44.972    -8.616   -10.659    43.470    -8.615   -10.659
   41.969    -8.613   -10.659    40.467    -8.612   -10.658
   38.966    -8.610   -10.658    37.464    -8.608   -10.658
   35.963    -8.607   -10.658    34.461    -8.605   -10.657
   32.959    -8.603   -10.657
   44.919    -9.875   -12.163    43.655    -9.873   -12.163
   42.390    -9.871   -12.163    41.126    -9.869   -12.162
   39.862    -9.867   -12.162    38.598    -9.865   -12.162
   37.334    -9.863   -12.161    36.069    -9.861   -12.161
   34.805    -9.859   -12.161
   44.866   -11.133   -13.668    43.839   -11.131   -13.667
   42.812   -11.129   -13.667    41.785   -11.127   -13.667
   40.759   -11.124   -13.666    39.732   -11.122   -13.666
   38.705   -11.120   -13.665    37.678   -11.117   -13.665
   36.651   -11.115   -13.665
   44.813   -12.392   -15.172    44.024   -12.389   -15.172
   43.234   -12.387   -15.171    42.445   -12.384   -15.171
   41.655   -12.381   -15.170    40.866   -12.379   -15.170
   40.076   -12.376   -15.169    39.287   -12.374   -15.169
   38.497   -12.371   -15.168
$POINTS NETWORK =    ZCAN1
1.0
2.0
      9.0       9.0
   45.236     2.324     3.138    42.548     2.324     3.138
```

```
131    39.859    2.324    3.138   37.171    2.324    3.138
132    34.483    2.324    3.138   31.795    2.324    3.138
133    29.107    2.324    3.138   26.418    2.324    3.138
134    23.730    2.324    3.138
135    45.183    3.583    4.642   42.732    3.582    4.642
136    40.281    3.582    4.642   37.830    3.582    4.642
137    35.380    3.581    4.642   32.929    3.581    4.642
138    30.478    3.581    4.642   28.027    3.580    4.642
139    25.576    3.580    4.642
140    45.130    4.841    6.146   42.917    4.840    6.146
141    40.703    4.840    6.146   38.489    4.839    6.146
142    36.276    4.839    6.146   34.063    4.838    6.146
143    31.849    4.837    6.146   29.635    4.837    6.146
144    27.422    4.836    6.145
145    45.077    6.100    7.650   43.101    6.099    7.650
146    41.125    6.098    7.650   39.149    6.097    7.650
147    37.173    6.096    7.650   35.196    6.095    7.650
148    33.220    6.094    7.650   31.244    6.093    7.649
149    29.268    6.092    7.649
150    45.025    7.358    9.155   43.286    7.357    9.155
151    41.547    7.355    9.154   '39.808   7.354    9.154
152    38.069    7.353    9.154   36.330    7.352    9.154
153    34.591    7.350    9.153   32.853    7.349    9.153
154    31.114    7.348    9.153
155    44.972    8.616   10.659   43.470    8.615   10.659
156    41.969    8.613   10.659   40.467    8.612   10.658
157    38.966    8.610   10.658   37.464    8.608   10.658
158    35.963    8.607   10.658   34.461    8.605   10.657
159    32.959    8.603   10.657
160    44.919    9.875   12.163   43.655    9.873   12.163
161    42.390    9.871   12.163   41.126    9.869   12.162
162    39.862    9.867   12.162   38.598    9.865   12.162
163    37.334    9.863   12.161   36.069    9.861   12.161
164    34.805    9.859   12.161
165    44.866   11.133   13.668   43.839   11.131   13.667
166    42.812   11.129   13.667   41.785   11.127   13.667
167    40.759   11.124   13.666   39.732   11.122   13.666
168    38.705   11.120   13.665   37.678   11.117   13.665
169    36.651   11.115   13.665
170    44.813   12.392   15.172   44.024   12.389   15.172
171    43.234   12.387   15.171   42.445   12.384   15.171
172    41.655   12.382   15.170   40.866   12.379   15.170
173    40.076   12.376   15.169   39.287   12.374   15.169
174    38.497   12.371   15.168
175 $POINTS NETWORK =     ZCAN2
176 1.0
177 2.0
178       9.0      9.0
179    45.236   -3.138    2.324   42.548   -3.138    2.324
180    39.859   -3.138    2.324   37.171   -3.138    2.324
181    34.483   -3.138    2.324   31.795   -3.138    2.324
182    29.107   -3.138    2.324   26.418   -3.138    2.324
183    23.730   -3.138    2.324
184    45.183   -4.642    3.583   42.732   -4.642    3.582
185    40.281   -4.642    3.582   37.830   -4.642    3.582
186    35.380   -4.642    3.581   32.929   -4.642    3.581
187    30.478   -4.642    3.581   28.027   -4.642    3.580
```

```
   25.576   -4.642    3.580
   45.130   -6.146    4.841   42.917   -6.146    4.840
   40.703   -6.146    4.840   38.489   -6.146    4.839
   36.276   -6.146    4.839   34.063   -6.146    4.838
   31.849   -6.146    4.837   29.635   -6.146    4.837
   27.422   -6.145    4.836
   45.077   -7.650    6.100   43.101   -7.650    6.099
   41.125   -7.650    6.098   39.149   -7.650    6.097
   37.173   -7.650    6.096   35.196   -7.650    6.095
   33.220   -7.650    6.094   31.244   -7.649    6.093
   29.268   -7.649    6.092
   45.025   -9.155    7.358   43.286   -9.155    7.357
   41.547   -9.154    7.355   39.808   -9.154    7.354
   38.069   -9.154    7.353   36.330   -9.154    7.352
   34.591   -9.153    7.350   32.853   -9.153    7.349
   31.114   -9.153    7.348
   44.972  -10.659    8.616   43.470  -10.659    8.615
   41.969  -10.659    8.613   40.467  -10.658    8.612
   38.966  -10.658    8.610   37.464  -10.658    8.608
   35.963  -10.658    8.607   34.461  -10.657    8.605
   32.959  -10.657    8.603
   44.919  -12.163    9.875   43.655  -12.163    9.873
   42.390  -12.163    9.871   41.126  -12.162    9.869
   39.862  -12.162    9.867   38.598  -12.162    9.865
   37.334  -12.161    9.863   36.069  -12.161    9.861
   34.805  -12.161    9.859
   44.866  -13.668   11.133   43.839  -13.667   11.131
   42.812  -13.667   11.129   41.785  -13.667   11.127
   40.759  -13.666   11.124   39.732  -13.666   11.122
   38.705  -13.665   11.120   37.678  -13.665   11.117
   36.651  -13.665   11.115
   44.813  -15.172   12.392   44.024  -15.172   12.389
   43.234  -15.171   12.387   42.445  -15.171   12.384
   41.655  -15.170   12.382   40.866  -15.170   12.379
   40.076  -15.169   12.376   39.287  -15.169   12.374
   38.497  -15.168   12.371
$POINTS NETWORK =    ZNOSF
1.0
1.0
      4.0     13.0
    8.499    0.000    3.999    2.498    0.000    3.564
    0.482    0.000    1.853    0.000    0.000    0.000
    8.499    1.995    3.465    2.498    1.778    3.088
    0.482    0.924    1.605    0.000    0.000    0.000
    8.499    3.463    2.007    2.498    3.086    1.788
    0.482    1.604    0.930    0.000    0.000    0.000
    8.499    3.999    0.000    2.498    3.565    0.000
    0.482    1.853    0.000    0.000    0.000    0.000
    8.499    3.463   -2.007    2.498    3.086   -1.789
    0.482    1.604   -0.930    0.000    0.000    0.000
    8.499    2.007   -3.463    2.498    1.789   -3.087
    0.482    0.930   -1.604    0.000    0.000    0.000
    8.499    0.000   -4.000    2.498    0.000   -3.565
    0.482    0.000   -1.853    0.000    0.000    0.000
    8.499   -2.007   -3.463    2.498   -1.788   -3.086
    0.482   -0.930   -1.604    0.000    0.000    0.000
    8.499   -3.463   -2.007    2.498   -3.086   -1.789
```

```
      0.482    -1.604    -0.930     0.000     0.000     0.000
      8.499    -3.999     0.000     2.498    -3.565     0.000
      0.482    -1.853     0.000     0.000     0.000     0.000
      8.499    -3.463     2.007     2.498    -3.086     1.788
      0.482    -1.604     0.930     0.000     0.000     0.000
      8.499    -1.995     3.464     2.498    -1.778     3.088
      0.482    -0.924     1.605     0.000     0.000     0.000
      8.499     0.000     3.999     2.498     0.000     3.565
      0.482     0.000     1.853     0.000     0.000     0.000
$POINTS NETWORK =  ZNOSAFT
1.0
1.0
       13.0       2.0
      8.499     0.000     3.999     8.499     1.995     3.465
      8.499     3.463     2.007     8.499     3.999     0.000
      8.499     3.463    -2.007     8.499     2.007    -3.463
      8.499     0.000    -4.000     8.499    -2.007    -3.463
      8.499    -3.463    -2.007     8.499    -3.999     0.000
      8.499    -3.463     2.007     8.499    -1.995     3.464
      8.499     0.000     3.999
     21.730     0.000     3.999    21.730     1.995     3.465
     21.730     3.463     2.007    21.730     3.999     0.000
     21.730     3.463    -2.007    21.730     2.007    -3.463
     21.730     0.000    -4.000    21.730    -2.007    -3.463
     21.730    -3.463    -2.007    21.730    -3.999     0.000
     21.730    -3.463     2.007    21.730    -1.995     3.465
     21.730     0.000     3.999
$POINTS NETWORK = ZCANFWD1
1.0
1.0
        3.0      13.0
     23.730    -3.138     2.324    22.730    -3.300     2.165
     21.730    -3.463     2.007
     23.730    -1.995     3.465    22.730    -1.995     3.465
     21.730    -1.995     3.465
     23.730     0.000     4.000    22.730     0.000     4.000
     21.730     0.000     3.999
     23.730     2.324     3.138    22.730     2.159     3.301
     21.730     1.995     3.465
     23.730     3.463     2.007    22.730     3.463     2.007
     21.730     3.463     2.007
     23.730     4.000     0.000    22.730     4.000     0.000
     21.730     3.999     0.000
     23.730     3.138    -2.324    22.730     3.301    -2.166
     21.730     3.463    -2.007
     23.730     2.007    -3.464    22.730     2.007    -3.464
     21.730     2.007    -3.463
     23.730     0.000    -4.000    22.730     0.000    -4.000
     21.730     0.000    -4.000
     23.730    -2.324    -3.138    22.730    -2.165    -3.301
     21.730    -2.007    -3.463
     23.730    -3.463    -2.007    22.730    -3.463    -2.007
     21.730    -3.463    -2.007
     23.730    -4.000     0.000    22.730    -4.000     0.000
     21.730    -3.999     0.000
     23.730    -3.138     2.324    22.730    -3.300     2.165
     21.730    -3.463     2.007
```

```
$POINTS NETWORK =    BODCAN1
1.
1.        0.        0.        0.        1.
4.        2.
     23.730     2.324     3.138    23.730     0.000     4.000
     23.730    -1.995     3.465    23.730    -3.138     2.324
     45.236     2.324     3.138    45.236     0.000     4.000
     45.236    -1.995     3.465    45.236    -3.138     2.324
$POINTS NETWORK =    BODCAN2
1.
1.        0.        0.        0.        1.
4.        2.
     23.730    -3.138     2.324    23.730    -4.000     0.000
     23.730    -3.463    -2.007    23.730    -2.324    -3.138
     45.236    -3.138     2.324    45.236    -4.000     0.000
     45.236    -3.463    -2.007    45.236    -2.324    -3.138
$POINTS NETWORK =    BODCAN3
1.
1.        0.        0.        0.        1.
4.        2.
     23.730    -2.324    -3.138    23.730     0.000    -4.000
     23.730     2.007    -3.464    23.730     3.138    -2.324
     45.236    -2.324    -3.138    45.236     0.000    -4.000
     45.236     2.007    -3.464    45.236     3.138    -2.324
$POINTS NETWORK =    BODCAN4
1.
1.        0.        0.        0.        1.
4.        2.
     23.730     3.138    -2.324    23.730     4.000     0.000
     23.730     3.463     2.007    23.730     2.324     3.138
     45.236     3.138    -2.324    45.236     4.000     0.000
     45.236     3.463     2.007    45.236     2.324     3.138
$POINTS NETWORK = ZCANAFT1
1.0
1.0       0.        0.        0.        1.
        3.0      13.0
     47.236    -3.463     2.007    46.236    -3.300     2.165
     45.236    -3.138     2.324
     47.236    -4.000     0.000    45.236    -4.000     0.000
     45.236    -4.000     0.000
     47.236    -3.463    -2.007    46.236    -3.463    -2.007
     45.236    -3.463    -2.007
     47.236    -2.007    -3.464    46.236    -2.166    -3.301
     45.236    -2.324    -3.138
     47.236     0.000    -4.000    46.236     0.000    -4.000
     45.236     0.000    -4.000
     47.236     2.007    -3.464    46.236     2.007    -3.464
     45.236     2.007    -3.464
     47.236     3.464    -2.007    46.236     3.301    -2.166
     45.236     3.138    -2.324
     47.236     4.000     0.000    46.236     4.000     0.000
     45.236     4.000     0.000
     47.236     3.463     2.007    46.236     3.463     2.007
     45.236     3.463     2.007
     47.236     1.995     3.465    46.236     2.159     3.301
     45.236     2.324     3.138
     47.236     0.000     4.000    46.236     0.000     4.000
```

```
     45.236     0.000     4.000
     47.236    -1.995     3.465    46.236    -1.995     3.465
     45.236    -1.995     3.465
     47.236    -3.463     2.007    46.236    -3.300     2.165
     45.236    -3.138     2.324
$POINTS NETWORK = ZCANAFT2
1.0
1.0       0.        0.        0.        1.
       13.0       2.0
     53.318     0.000     4.000    53.318     1.995     3.465
     53.318     3.463     2.007    53.318     4.000    -0.001
     53.318     3.464    -2.008    53.318     2.007    -3.464
     53.318     0.000    -4.000    53.318    -2.007    -3.464
     53.318    -3.463    -2.007    53.318    -4.000    -0.001
     53.318    -3.463     2.007    53.318    -1.995     3.465
     53.318     0.000     4.000
     47.236     0.000     4.000    47.236     1.995     3.465
     47.236     3.463     2.007    47.236     4.000     0.000
     47.236     3.464    -2.007    47.236     2.007    -3.464
     47.236     0.000    -4.000    47.236    -2.007    -3.464
     47.236    -3.463    -2.007    47.236    -4.000     0.000
     47.236    -3.463     2.007    47.236    -1.995     3.465
     47.236     0.000     4.000
$POINTS NETWORK =     ZBOD2
1.0
1.0
        4.0      13.0
    132.459    -3.616     6.281    71.254    -3.616     6.281
     61.785    -3.167     5.500    53.318    -1.995     3.465
    132.459     0.000     7.250    71.254     0.000     7.250
     61.785     0.000     6.349    53.318     0.000     4.000
    132.459     3.616     6.281    71.254     3.616     6.281
     61.785     3.166     5.499    53.318     1.995     3.465
    132.459     6.278     3.638    71.254     6.278     3.638
     61.785     5.497     3.186    53.318     3.463     2.007
    132.459     7.251     0.000    71.254     7.250     0.000
     61.785     6.349     0.000    53.318     4.000    -0.001
    132.459     6.279    -3.638    71.254     6.278    -3.638
     61.785     5.498    -3.186    53.318     3.464    -2.008
    132.459     3.639    -6.278    71.254     3.638    -6.279
     61.785     3.186    -5.498    53.318     2.007    -3.464
    132.459     0.001    -7.251    71.254     0.000    -7.250
     61.785     0.001    -6.349    53.318     0.000    -4.000
    132.459    -3.638    -6.279    71.254    -3.638    -6.279
     61.785    -3.185    -5.498    53.318    -2.007    -3.464
    132.459    -6.278    -3.639    71.254    -6.278    -3.638
     61.785    -5.497    -3.186    53.318    -3.463    -2.007
    132.459    -7.250    -0.001    71.254    -7.250     0.000
     61.785    -6.349    -0.001    53.318    -4.000    -0.001
    132.459    -6.278     3.638    71.254    -6.278     3.638
     61.785    -5.497     3.185    53.318    -3.463     2.007
    132.459    -3.616     6.281    71.254    -3.616     6.281
     61.785    -3.167     5.500    53.318    -1.995     3.465
$POINTS NETWORK =     ZBODA4
1.0
1.0
        4.0      11.0
```

```
   132.459    -6.278    -3.639   132.459    -7.250    -0.000
   132.459    -6.278     3.638   132.459    -3.616     6.281
   134.175    -6.549    -3.796   134.175    -7.564    -0.000
   134.175    -6.549     3.795   134.175    -3.773     6.552
   135.865    -6.816    -3.951   135.865    -7.872     0.000
   135.865    -6.817     3.950   135.865    -3.927     6.820
   137.500    -7.075    -4.100   137.500    -8.171     0.000
   137.500    -7.075     4.100   137.500    -4.076     7.078
   138.947    -7.239    -4.196   138.947    -8.361     0.000
   138.947    -7.240     4.195   138.947    -4.170     7.243
   140.100    -7.341    -4.254   140.100    -8.479     0.000
   140.100    -7.341     4.254   140.100    -4.229     7.344
   141.551    -7.469    -4.328   141.551    -8.626     0.000
   141.551    -7.469     4.328   141.551    -4.302     7.472
   143.975    -7.420    -4.300   143.975    -8.569     0.000
   143.975    -7.420     4.299   143.975    -4.274     7.423
   148.235    -6.650    -3.854   148.235    -7.680     0.000
   148.235    -6.649     3.853   148.235    -3.830     6.652
   153.934    -5.619    -3.257   153.934    -6.489     0.000
   153.934    -5.619     3.256   153.934    -3.237     5.621
   160.353    -4.457    -2.584   160.353    -5.148    -0.000
   160.353    -4.457     2.583   160.353    -2.568     4.459
$POINTS NETWORK =    ZBODA3
1.0
1.0
       4.0      11.0
   132.459     3.639    -6.278   132.459     0.000    -7.251
   132.459    -3.638    -6.279   132.459    -6.278    -3.639
   134.175     3.796    -6.550   134.175     0.000    -7.564
   134.175    -3.795    -6.550   134.175    -6.549    -3.796
   135.865     3.951    -6.817   135.865     0.000    -7.873
   135.865    -3.950    -6.817   135.865    -6.816    -3.951
   137.500     4.100    -7.076   137.500     0.000    -8.172
   137.500    -4.100    -7.076   137.500    -7.075    -4.100
   138.947     4.195    -7.240   138.947     0.000    -8.361
   138.947    -4.195    -7.240   138.947    -7.239    -4.196
   140.100     4.254    -7.341   140.100     0.000    -8.479
   140.100    -4.254    -7.341   140.100    -7.341    -4.254
   141.551     4.328    -7.469   141.551     0.000    -8.626
   141.551    -4.328    -7.469   141.551    -7.469    -4.328
   143.975     4.300    -7.420   143.975     0.000    -8.569
   143.975    -4.300    -7.420   143.975    -7.420    -4.300
   148.235     3.853    -6.650   148.235     0.000    -7.680
   148.235    -3.853    -6.650   148.235    -6.650    -3.854
   153.934     3.256    -5.619   153.934     0.000    -6.489
   153.934    -3.256    -5.619   153.934    -5.619    -3.257
   160.353     2.584    -4.458   160.353     0.000    -5.148
   160.353    -2.583    -4.458   160.353    -4.457    -2.584
$POINTS NETWORK =    ZBODA2
1.0
1.0
       4.0      11.0
   132.459     6.278     3.638   132.459     7.251     0.000
   132.459     6.279    -3.638   132.459     3.639    -6.278
   134.175     6.550     3.795   134.175     7.564     0.000
   134.175     6.550    -3.796   134.175     3.796    -6.550
   135.865     6.817     3.950   135.865     7.873     0.000
```

```
    135.865     6.817    -3.950   135.865     3.951    -6.817
    137.500     7.075     4.100   137.500     8.172     0.000
    137.500     7.075    -4.100   137.500     4.100    -7.076
    138.947     7.240     4.195   138.947     8.361     0.000
    138.947     7.239    -4.196   138.947     4.195    -7.240
    140.100     7.341     4.254   140.100     8.479     0.000
    140.100     7.341    -4.254   140.100     4.254    -7.341
    141.551     7.469     4.328   141.551     8.626     0.000
    141.551     7.469    -4.328   141.551     4.328    -7.469
    143.975     7.420     4.300   143.975     8.569     0.000
    143.975     7.420    -4.300   143.975     4.300    -7.420
    148.235     6.649     3.853   148.235     7.680     0.000
    148.235     6.649    -3.853   148.235     3.853    -6.650
    153.934     5.618     3.256   153.934     6.489     0.000
    153.934     5.619    -3.256   153.934     3.256    -5.619
    160.353     4.457     2.583   160.353     5.148     0.000
    160.353     4.457    -2.583   160.353     2.584    -4.458
$POINTS NETWORK =     ZFIN2
1.0
2.0
       11.0       7.0
    132.459     6.278     3.638   134.176     6.550     3.795
    135.865     6.817     3.950   137.500     7.075     4.100
    138.948     7.240     4.195   140.101     7.341     4.254
    141.551     7.469     4.328   143.975     7.420     4.300
    148.235     6.649     3.853   153.934     5.618     3.256
    160.353     4.457     2.583
    132.480     7.119     4.856   133.996     7.408     5.052
    135.495     7.695     5.246   136.960     7.975     5.436
    138.272     8.147     5.552   139.314     8.249     5.619
    140.676     8.382     5.708   143.055     8.379     5.718
    147.477     7.746     5.351   153.507     6.882     4.850
    160.341     5.903     4.283
    132.502     7.960     6.074   133.818     8.267     6.307
    135.128     8.572     6.540   136.422     8.874     6.770
    137.598     9.055     6.907   138.530     9.156     6.983
    139.801     9.294     7.086   142.132     9.335     7.134
    146.713     8.835     6.844   153.075     8.140     6.441
    160.328     7.348     5.983
    132.523     8.801     7.291   133.642     9.125     7.562
    134.763     9.448     7.833   135.885     9.773     8.104
    136.926     9.962     8.261   137.749    10.062     8.344
    138.929    10.205     8.462   141.207    10.288     8.548
    145.945     9.917     8.333   152.641     9.394     8.030
    160.316     8.794     7.682
    132.544     9.642     8.508   133.469     9.982     8.815
    134.402    10.324     9.123   135.350    10.671     9.437
    136.255    10.869     9.615   136.970    10.966     9.702
    138.059    11.115     9.835   140.281    11.238     9.960
    145.175    10.994     9.819   152.205    10.643     9.616
    160.303    10.239     9.382
    132.566    10.484     9.726   133.301    10.838    10.066
    134.047    11.198    10.413   134.817    11.569    10.770
    135.587    11.775    10.968   136.195    11.869    11.058
    137.190    12.023    11.206   139.354    12.185    11.371
    144.403    12.065    11.301   151.768    11.888    11.199
    160.291    11.685    11.081
```

58

```
 132.587   11.325   10.943  133.137   11.695   11.318
 133.701   12.073   11.702  134.288   12.467   12.102
 134.924   12.681   12.320  135.424   12.769   12.410
 136.323   12.929   12.574  138.428   13.131   12.781
 143.632   13.131   12.781  151.331   13.130   12.781
 160.278   13.130   12.781
$POINTS NETWORK =    ZFIN4
1.0
2.0
    11.0      7.0
 132.459   -6.278   -3.639  134.175   -6.549   -3.796
 135.865   -6.816   -3.951  137.500   -7.075   -4.100
 138.947   -7.239   -4.196  140.100   -7.341   -4.254
 141.551   -7.469   -4.328  143.975   -7.420   -4.300
 148.235   -6.650   -3.854  153.934   -5.619   -3.257
 160.353   -4.457   -2.584
 132.480   -7.119   -4.856  133.996   -7.408   -5.052
 135.495   -7.695   -5.246  136.960   -7.975   -5.436
 138.272   -8.147   -5.552  139.314   -8.249   -5.619
 140.676   -8.382   -5.708  143.055   -8.379   -5.718
 147.477   -7.746   -5.351  153.507   -6.882   -4.850
 160.341   -5.903   -4.283
 132.502   -7.960   -6.074  133.818   -8.267   -6.307
 135.128   -8.572   -6.540  136.422   -8.874   -6.770
 137.598   -9.055   -6.907  138.530   -9.156   -6.983
 139.801   -9.294   -7.086  142.132   -9.335   -7.134
 146.713   -8.835   -6.844  153.075   -8.140   -6.441
 160.328   -7.348   -5.983
 132.523   -8.801   -7.291  133.642   -9.125   -7.562
 134.763   -9.448   -7.833  135.885   -9.773   -8.104
 136.926   -9.962   -8.261  137.749  -10.062   -8.344
 138.929  -10.205   -8.462  141.207  -10.288   -8.548
 145.945   -9.917   -8.333  152.641   -9.394   -8.030
 160.316   -8.794   -7.682
 132.544   -9.642   -8.508  133.469   -9.982   -8.815
 134.402  -10.324   -9.123  135.350  -10.671   -9.437
 136.255  -10.869   -9.615  136.970  -10.966   -9.702
 138.059  -11.115   -9.835  140.281  -11.238   -9.960
 145.175  -10.994   -9.819  152.205  -10.643   -9.616
 160.303  -10.239   -9.382
 132.566  -10.484   -9.726  133.301  -10.838  -10.066
 134.047  -11.198  -10.413  134.817  -11.569  -10.770
 135.587  -11.775  -10.968  136.195  -11.869  -11.058
 137.190  -12.023  -11.206  139.354  -12.185  -11.371
 144.403  -12.065  -11.301  151.768  -11.888  -11.199
 160.291  -11.685  -11.081
 132.587  -11.325  -10.943  133.137  -11.695  -11.318
 133.701  -12.073  -11.702  134.288  -12.467  -12.102
 134.924  -12.681  -12.320  135.424  -12.769  -12.410
 136.323  -12.929  -12.574  138.428  -13.131  -12.781
 143.632  -13.131  -12.781  151.331  -13.130  -12.781
 160.278  -13.130  -12.781
$POINTS NETWORK =    ZFIN3
1.0
2.0
    11.0      7.0
 132.459    3.639   -6.278  134.175    3.796   -6.550
```

135.865	3.951	-6.817	137.500	4.100	-7.076
138.947	4.195	-7.240	140.100	4.254	-7.341
141.551	4.328	-7.469	143.975	4.300	-7.420
148.235	3.853	-6.650	153.934	3.256	-5.619
160.353	2.584	-4.458			
132.480	4.856	-7.119	133.996	5.052	-7.408
135.495	5.246	-7.695	136.960	5.436	-7.975
138.272	5.552	-8.147	139.314	5.619	-8.249
140.676	5.708	-8.382	143.055	5.718	-8.379
147.477	5.351	-7.746	153.507	4.850	-6.882
160.341	4.283	-5.903			
132.502	6.074	-7.960	133.818	6.307	-8.267
135.128	6.540	-8.572	136.422	6.770	-8.874
137.598	6.907	-9.055	138.530	6.983	-9.156
139.801	7.086	-9.294	142.132	7.134	-9.335
146.713	6.844	-8.835	153.075	6.441	-8.140
160.328	5.983	-7.348			
132.523	7.291	-8.801	133.642	7.562	-9.125
134.763	7.833	-9.448	135.885	8.104	-9.773
136.926	8.261	-9.962	137.749	8.344	-10.062
138.929	8.462	-10.205	141.207	8.548	-10.288
145.945	8.333	-9.917	152.641	8.030	-9.394
160.316	7.682	-8.794			
132.544	8.508	-9.642	133.469	8.815	-9.982
134.402	9.123	-10.324	135.350	9.437	-10.671
136.255	9.615	-10.869	136.970	9.702	-10.966
138.059	9.835	-11.115	140.281	9.960	-11.238
145.175	9.819	-10.994	152.205	9.616	-10.643
160.303	9.382	-10.239			
132.566	9.726	-10.484	133.301	10.066	-10.838
134.047	10.413	-11.198	134.817	10.770	-11.569
135.587	10.968	-11.775	136.195	11.058	-11.869
137.190	11.206	-12.023	139.354	11.371	-12.185
144.403	11.301	-12.065	151.768	11.199	-11.888
160.291	11.081	-11.685			
132.587	10.943	-11.325	133.137	11.318	-11.695
133.701	11.702	-12.073	134.288	12.102	-12.467
134.924	12.320	-12.681	135.424	12.410	-12.769
136.323	12.574	-12.929	138.428	12.781	-13.131
143.632	12.781	-13.131	151.331	12.781	-13.130
160.278	12.781	-13.130			

$POINTS NETWORK = ZBODA1

1.0

1.0

4.0	11.0				
132.459	-3.616	6.281	132.459	0.000	7.250
132.459	3.616	6.281	132.459	6.278	3.638
134.175	-3.773	6.552	134.175	0.000	7.563
134.175	3.773	6.552	134.175	6.550	3.795
135.865	-3.927	6.820	135.865	0.000	7.872
135.865	3.927	6.820	135.865	6.817	3.950
137.500	-4.076	7.078	137.500	0.000	8.170
137.500	4.076	7.078	137.500	7.075	4.100
138.947	-4.170	7.243	138.947	0.000	8.360
138.947	4.170	7.243	138.947	7.240	4.195
140.100	-4.229	7.344	140.100	0.000	8.477
140.100	4.229	7.344	140.100	7.341	4.254

```
141.551   -4.302    7.472  141.551    0.000    8.625
141.551    4.302    7.472  141.551    7.469    4.328
143.975   -4.274    7.423  143.975    0.000    8.568
143.975    4.274    7.423  143.975    7.420    4.300
148.235   -3.830    6.652  148.235    0.000    7.679
148.235    3.830    6.652  148.235    6.649    3.853
153.934   -3.237    5.621  153.934    0.000    6.488
153.934    3.236    5.621  153.934    5.618    3.256
160.353   -2.568    4.459  160.353    0.000    5.147
160.353    2.568    4.460  160.353    4.457    2.583
$POINTS NETWORK =    ZFIN1
1.0
2.0
   11.0      7.0
132.459   -3.616    6.281  134.176   -3.773    6.552
135.865   -3.927    6.820  137.500   -4.076    7.078
138.948   -4.170    7.243  140.101   -4.229    7.344
141.551   -4.302    7.472  143.975   -4.274    7.423
148.235   -3.830    6.652  153.934   -3.237    5.621
160.353   -2.568    4.459
132.480   -4.856    7.119  133.996   -5.052    7.408
135.495   -5.246    7.695  136.960   -5.436    7.975
138.272   -5.552    8.147  139.314   -5.619    8.249
140.676   -5.708    8.382  143.055   -5.718    8.379
147.477   -5.351    7.746  153.507   -4.850    6.882
160.341   -4.283    5.903
132.502   -6.074    7.960  133.818   -6.307    8.267
135.128   -6.540    8.572  136.422   -6.770    8.874
137.598   -6.907    9.055  138.530   -6.983    9.156
139.801   -7.086    9.294  142.132   -7.134    9.335
146.713   -6.844    8.835  153.075   -6.441    8.140
160.328   -5.983    7.348
132.523   -7.291    8.801  133.642   -7.562    9.125
134.763   -7.833    9.448  135.885   -8.104    9.773
136.926   -8.261    9.962  137.749   -8.344   10.062
138.929   -8.462   10.205  141.207   -8.548   10.288
145.945   -8.333    9.917  152.641   -8.030    9.394
160.316   -7.682    8.794
132.544   -8.508    9.642  133.469   -8.815    9.982
134.402   -9.123   10.324  135.350   -9.437   10.671
136.255   -9.615   10.869  136.970   -9.702   10.966
138.059   -9.835   11.115  140.281   -9.960   11.238
145.175   -9.819   10.994  152.205   -9.616   10.643
160.303   -9.382   10.239
132.566   -9.726   10.484  133.301  -10.066   10.838
134.047  -10.413   11.198  134.817  -10.770   11.569
135.587  -10.968   11.775  136.195  -11.058   11.869
137.190  -11.206   12.023  139.354  -11.371   12.185
144.403  -11.301   12.065  151.768  -11.199   11.888
160.291  -11.081   11.685
132.587  -10.943   11.325  133.137  -11.318   11.695
133.701  -11.702   12.073  134.288  -12.102   12.467
134.924  -12.320   12.681  135.424  -12.410   12.769
136.323  -12.574   12.929  138.428  -12.781   13.131
143.632  -12.781   13.131  151.331  -12.781   13.130
160.278  -12.781   13.130
$POINTS NETWORK =    ZEND
```

```
1.0
5.0        0.        0.        0.        0.
      13.0       2.0
    160.353    -2.568     4.459   160.353     0.000     5.148
    160.353     2.568     4.460   160.353     4.457     2.583
    160.353     5.148     0.000   160.353     4.457    -2.583
    160.353     2.584    -4.458   160.353     0.000    -5.148
    160.353    -2.583    -4.458   160.353    -4.457    -2.584
    160.353    -5.148    -0.001   160.353    -4.457     2.583
    160.353    -2.568     4.459
    160.350     0.000     0.000   160.350     0.000     0.000
    160.350     0.000     0.000   160.350     0.000     0.000
    160.350     0.000     0.000   160.350     0.000     0.000
    160.350     0.000     0.000   160.350     0.000     0.000
    160.350     0.000     0.000   160.350     0.000     0.000
    160.350     0.000     0.000   160.350     0.000     0.000
    160.350     0.000     0.000
$POINTS NETWORK = ZFINWAK2
1.0
18.0       0.        0.        0.        1.
       7.0       2.0
    160.353     4.457     2.583   160.341     5.903     4.283
    160.328     7.348     5.983   160.316     8.794     7.682
    160.303    10.239     9.382   160.291    11.685    11.081
    160.278    13.130    12.781
   1160.353     4.457     2.583  1160.341     5.903     4.283
   1160.328     7.348     5.983  1160.316     8.794     7.682
   1160.303    10.239     9.382  1160.291    11.685    11.081
   1160.278    13.130    12.781
$POINTS NETWORK = ZFINWAK1
1.0
18.0       0.        0.        0.        1.
       7.0       2.0
    160.353    -2.568     4.459   160.341    -4.283     5.903
    160.328    -5.983     7.348   160.316    -7.682     8.794
    160.303    -9.382    10.239   160.291   -11.081    11.685
    160.278   -12.781    13.130
   1160.353    -2.568     4.459  1160.341    -4.283     5.903
   1160.328    -5.983     7.348  1160.316    -7.682     8.794
   1160.303    -9.382    10.239  1160.291   -11.081    11.685
   1160.278   -12.781    13.130
$POINTS NETWORK = ZFINWAK4
1.0
18.0       0.        0.        0.        1.
       7.0       2.0
    160.353    -4.457    -2.584   160.341    -5.903    -4.283
    160.328    -7.348    -5.983   160.316    -8.794    -7.682
    160.303   -10.239    -9.382   160.291   -11.685   -11.081
    160.278   -13.130   -12.781
   1160.353    -4.457    -2.584  1160.341    -5.903    -4.283
   1160.328    -7.348    -5.983  1160.316    -8.794    -7.682
   1160.303   -10.239    -9.382  1160.291   -11.685   -11.081
   1160.278   -13.130   -12.781
$POINTS NETWORK = ZFINWAK3
1.0
18.0       0.        0.        0.        1.
       7.0       2.0
```

```
   160.353     2.584    -4.458   160.341     4.283    -5.903
   160.328     5.983    -7.348   160.316     7.682    -8.794
   160.303     9.382   -10.239   160.291    11.081   -11.685
   160.278    12.781   -13.130
  1160.353     2.584    -4.458  1160.341     4.283    -5.903
  1160.328     5.983    -7.348  1160.316     7.682    -8.794
  1160.303     9.382   -10.239  1160.291    11.081   -11.685
  1160.278    12.781   -13.130
$POINTS NETWORK = ZCNBDWK1
1.0
18.0        1.        0.        0.        1.
       9.0      16.0
    45.236    -3.138     2.324    45.183    -4.642     3.583
    45.130    -6.146     4.841    45.077    -7.650     6.100
    45.025    -9.155     7.358    44.972   -10.659     8.616
    44.919   -12.163     9.875    44.866   -13.668    11.133
    44.813   -15.172    12.392
    53.318    -3.463     2.007    53.265    -4.967     3.265
    53.212    -6.471     4.523    53.160    -7.976     5.782
    53.107    -9.480     7.040    53.054   -10.984     8.299
    53.001   -12.489     9.557    52.948   -13.993    10.816
    52.896   -15.497    12.074
    61.785    -5.497     3.185    61.732    -7.001     4.444
    61.679    -8.505     5.702    61.627   -10.010     6.960
    61.574   -11.514     8.219    61.521   -13.018     9.477
    61.468   -14.523    10.736    61.415   -16.027    11.994
    61.362   -17.531    13.253
    71.254    -6.278     3.638    71.201    -7.782     4.896
    71.148    -9.286     6.155    71.096   -10.790     7.413
    71.043   -12.295     8.672    70.990   -13.799     9.930
    70.937   -15.303    11.189    70.884   -16.808    12.447
    70.831   -18.312    13.705
   132.459    -6.278     3.638   132.406    -7.782     4.896
   132.353    -9.286     6.155   132.301   -10.791     7.413
   132.248   -12.295     8.672   132.195   -13.799     9.930
   132.142   -15.304    11.189   132.089   -16.808    12.447
   132.036   -18.312    13.705
   134.175    -6.549     3.795   134.122    -8.054     5.054
   134.070    -9.558     6.312   134.017   -11.062     7.570
   133.964   -12.566     8.829   133.911   -14.071    10.087
   133.858   -15.575    11.346   133.806   -17.079    12.604
   133.753   -18.583    13.863
   135.865    -6.817     3.950   135.812    -8.321     5.208
   135.759    -9.825     6.467   135.706   -11.329     7.725
   135.653   -12.834     8.984   135.600   -14.338    10.242
   135.548   -15.842    11.501   135.495   -17.347    12.759
   135.442   -18.851    14.018
   137.500    -7.075     4.100   137.447    -8.580     5.358
   137.394   -10.084     6.617   137.341   -11.588     7.875
   137.288   -13.092     9.134   137.236   -14.597    10.392
   137.183   -16.101    11.651   137.130   -17.605    12.909
   137.077   -19.109    14.168
   138.947    -7.240     4.195   138.895    -8.744     5.454
   138.842   -10.248     6.712   138.789   -11.752     7.971
   138.736   -13.257     9.229   138.683   -14.761    10.488
   138.631   -16.265    11.746   138.578   -17.770    13.004
   138.525   -19.274    14.263
```

```
  140.100   -7.341     4.254  140.048   -8.845    5.512
  139.995  -10.350     6.771  139.942  -11.854    8.029
  139.889  -13.358     9.288  139.836  -14.863   10.546
  139.784  -16.367    11.805  139.731  -17.871   13.063
  139.678  -19.375    14.322
  141.551   -7.469     4.328  141.498   -8.973    5.586
  141.445  -10.477     6.845  141.393  -11.981    8.103
  141.340  -13.486     9.362  141.287  -14.990   10.620
  141.234  -16.494    11.879  141.181  -17.999   13.137
  141.129  -19.503    14.396
  143.975   -7.420     4.299  143.923   -8.924    5.558
  143.870  -10.428     6.816  143.817  -11.933    8.075
  143.764  -13.437     9.333  143.711  -14.941   10.592
  143.658  -16.445    11.850  143.606  -17.950   13.109
  143.553  -19.454    14.367
  148.235   -6.649     3.853  148.182   -8.154    5.111
  148.129   -9.658     6.370  148.076  -11.162    7.628
  148.023  -12.667     8.887  147.971  -14.171   10.145
  147.918  -15.675    11.404  147.865  -17.179   12.662
  147.812  -18.684    13.921
  153.934   -5.619     3.256  153.881   -7.123    4.514
  153.828   -8.627     5.773  153.776  -10.131    7.031
  153.723  -11.636     8.290  153.670  -13.140    9.548
  153.617  -14.644    10.806  153.564  -16.149   12.065
  153.512  -17.653    13.323
  160.353   -4.457     2.583  160.301   -5.962    3.841
  160.248   -7.466     5.100  160.195   -8.970    6.358
  160.142  -10.475     7.617  160.089  -11.979    8.875
  160.036  -13.483    10.134  159.984  -14.987   11.392
  159.931  -16.492    12.651
 1160.353   -4.457     2.583 1160.301   -5.962    3.841
 1160.248   -7.466     5.100 1160.195   -8.970    6.358
 1160.142  -10.475     7.617 1160.089  -11.979    8.875
 1160.036  -13.483    10.134 1159.984  -14.987   11.392
 1159.931  -16.492    12.651
$POINTS NETWORK = ZCNBDWK2
1.0
18.0       1.         0.         0.         1.
        9.0      16.0
     45.236    -2.324    -3.138    45.183    -3.583    -4.642
     45.130    -4.841    -6.146    45.077    -6.100    -7.650
     45.025    -7.358    -9.155    44.972    -8.616   -10.659
     44.919    -9.875   -12.163    44.866   -11.133   -13.668
     44.813   -12.392   -15.172
     53.318    -2.007    -3.463    53.265    -3.265    -4.967
     53.212    -4.523    -6.471    53.160    -5.782    -7.976
     53.107    -7.040    -9.480    53.054    -8.299   -10.984
     53.001    -9.557   -12.489    52.948   -10.816   -13.993
     52.896   -12.074   -15.497
     61.785    -3.185    -5.497    61.732    -4.444    -7.001
     61.679    -5.702    -8.505    61.627    -6.960   -10.010
     61.574    -8.219   -11.514    61.521    -9.477   -13.018
     61.468   -10.736   -14.523    61.415   -11.994   -16.027
     61.362   -13.253   -17.531
     71.254    -3.638    -6.278    71.201    -4.896    -7.782
     71.148    -6.155    -9.286    71.096    -7.413   -10.790
     71.043    -8.672   -12.295    70.990    -9.930   -13.799
```

872	70.937	-11.189	-15.303	70.884	-12.447	-16.808
873	70.831	-13.705	-18.312			
874	132.459	-3.638	-6.278	132.406	-4.896	-7.782
875	132.353	-6.155	-9.286	132.301	-7.413	-10.791
876	132.248	-8.672	-12.295	132.195	-9.930	-13.799
877	132.142	-11.189	-15.304	132.089	-12.447	-16.808
878	132.036	-13.705	-18.312			
879	134.175	-3.795	-6.549	134.122	-5.054	-8.054
880	134.070	-6.312	-9.558	134.017	-7.570	-11.062
881	133.964	-8.829	-12.566	133.911	-10.087	-14.071
882	133.858	-11.346	-15.575	133.806	-12.604	-17.079
883	133.753	-13.863	-18.583			
884	135.865	-3.950	-6.817	135.812	-5.208	-8.321
885	135.759	-6.467	-9.825	135.706	-7.725	-11.329
886	135.653	-8.984	-12.834	135.600	-10.242	-14.338
887	135.548	-11.501	-15.842	135.495	-12.759	-17.347
888	135.442	-14.018	-18.851			
889	137.500	-4.100	-7.075	137.447	-5.358	-8.580
890	137.394	-6.617	-10.084	137.341	-7.875	-11.588
891	137.288	-9.134	-13.092	137.236	-10.392	-14.597
892	137.183	-11.651	-16.101	137.130	-12.909	-17.605
893	137.077	-14.168	-19.109			
894	138.947	-4.195	-7.240	138.895	-5.454	-8.744
895	138.842	-6.712	-10.248	138.789	-7.971	-11.752
896	138.736	-9.229	-13.257	138.683	-10.488	-14.761
897	138.631	-11.746	-16.265	138.578	-13.004	-17.770
898	138.525	-14.263	-19.274			
899	140.100	-4.254	-7.341	140.048	-5.512	-8.845
900	139.995	-6.771	-10.350	139.942	-8.029	-11.854
901	139.889	-9.288	-13.358	139.836	-10.546	-14.863
902	139.784	-11.805	-16.367	139.731	-13.063	-17.871
903	139.678	-14.322	-19.375			
904	141.551	-4.328	-7.469	141.498	-5.586	-8.973
905	141.445	-6.845	-10.477	141.393	-8.103	-11.981
906	141.340	-9.362	-13.486	141.287	-10.620	-14.990
907	141.234	-11.879	-16.494	141.181	-13.137	-17.999
908	141.129	-14.396	-19.503			
909	143.975	-4.299	-7.420	143.923	-5.558	-8.924
910	143.870	-6.816	-10.428	143.817	-8.075	-11.933
911	143.764	-9.333	-13.437	143.711	-10.592	-14.941
912	143.658	-11.850	-16.445	143.606	-13.109	-17.950
913	143.553	-14.367	-19.454			
914	148.235	-3.853	-6.649	148.182	-5.111	-8.154
915	148.129	-6.370	-9.658	148.076	-7.628	-11.162
916	148.023	-8.887	-12.667	147.971	-10.145	-14.171
917	147.918	-11.404	-15.675	147.865	-12.662	-17.179
918	147.812	-13.921	-18.684			
919	153.934	-3.256	-5.619	153.881	-4.514	-7.123
920	153.828	-5.773	-8.627	153.776	-7.031	-10.131
921	153.723	-8.290	-11.636	153.670	-9.548	-13.140
922	153.617	-10.806	-14.644	153.564	-12.065	-16.149
923	153.512	-13.323	-17.653			
924	160.353	-2.583	-4.457	160.301	-3.841	-5.962
925	160.248	-5.100	-7.466	160.195	-6.358	-8.970
926	160.142	-7.617	-10.475	160.089	-8.875	-11.979
927	160.036	-10.134	-13.483	159.984	-11.392	-14.987
928	159.931	-12.651	-16.492			

```
1160.353    -2.583    -4.457  1160.301    -3.841    -5.962
1160.248    -5.100    -7.466  1160.195    -6.358    -8.970
1160.142    -7.617   -10.475  1160.089    -8.875   -11.979
1160.036   -10.134   -13.483  1159.984   -11.392   -14.987
1159.931   -12.651   -16.492
$POINTS NETWORK = ZCNBDWK3
1.0
18.0       1.        0.        0.        1.
     9.0      16.0
  45.236     3.138    -2.324    45.183     4.642    -3.583
  45.130     6.146    -4.841    45.077     7.650    -6.100
  45.025     9.155    -7.358    44.972    10.659    -8.616
  44.919    12.163    -9.875    44.866    13.668   -11.133
  44.813    15.172   -12.392
  53.318     3.463    -2.007    53.265     4.967    -3.265
  53.212     6.471    -4.523    53.160     7.976    -5.782
  53.107     9.480    -7.040    53.054    10.984    -8.299
  53.001    12.489    -9.557    52.948    13.993   -10.816
  52.896    15.497   -12.074
  61.785     5.497    -3.185    61.732     7.001    -4.444
  61.679     8.505    -5.702    61.627    10.010    -6.960
  61.574    11.514    -8.219    61.521    13.018    -9.477
  61.468    14.523   -10.736    61.415    16.027   -11.994
  61.362    17.531   -13.253
  71.254     6.278    -3.638    71.201     7.782    -4.896
  71.148     9.286    -6.155    71.096    10.790    -7.413
  71.043    12.295    -8.672    70.990    13.799    -9.930
  70.937    15.303   -11.189    70.884    16.808   -12.447
  70.831    18.312   -13.705
 132.459     6.278    -3.638   132.406     7.782    -4.896
 132.353     9.286    -6.155   132.301    10.791    -7.413
 132.248    12.295    -8.672   132.195    13.799    -9.930
 132.142    15.304   -11.189   132.089    16.808   -12.447
 132.036    18.312   -13.705
 134.175     6.549    -3.795   134.122     8.054    -5.054
 134.070     9.558    -6.312   134.017    11.062    -7.570
 133.964    12.566    -8.829   133.911    14.071   -10.087
 133.858    15.575   -11.346   133.806    17.079   -12.604
 133.753    18.583   -13.863
 135.865     6.817    -3.950   135.812     8.321    -5.208
 135.759     9.825    -6.467   135.706    11.329    -7.725
 135.653    12.834    -8.984   135.600    14.338   -10.242
 135.548    15.842   -11.501   135.495    17.347   -12.759
 135.442    18.851   -14.018
 137.500     7.075    -4.100   137.447     8.580    -5.358
 137.394    10.084    -6.617   137.341    11.588    -7.875
 137.288    13.092    -9.134   137.236    14.597   -10.392
 137.183    16.101   -11.651   137.130    17.605   -12.909
 137.077    19.109   -14.168
 138.947     7.240    -4.195   138.895     8.744    -5.454
 138.842    10.248    -6.712   138.789    11.752    -7.971
 138.736    13.257    -9.229   138.683    14.761   -10.488
 138.631    16.265   -11.746   138.578    17.770   -13.004
 138.525    19.274   -14.263
 140.100     7.341    -4.254   140.048     8.845    -5.512
 139.995    10.350    -6.771   139.942    11.854    -8.029
 139.889    13.358    -9.288   139.836    14.863   -10.546
```

```
  139.784   16.367  -11.805   139.731   17.871  -13.063
  139.678   19.375  -14.322
  141.551    7.469   -4.328   141.498    8.973   -5.586
  141.445   10.477   -6.845   141.393   11.981   -8.103
  141.340   13.486   -9.362   141.287   14.990  -10.620
  141.234   16.494  -11.879   141.181   17.999  -13.137
  141.129   19.503  -14.396
  143.975    7.420   -4.299   143.923    8.924   -5.558
  143.870   10.428   -6.816   143.817   11.933   -8.075
  143.764   13.437   -9.333   143.711   14.941  -10.592
  143.658   16.445  -11.850   143.606   17.950  -13.109
  143.553   19.454  -14.367
  148.235    6.649   -3.853   148.182    8.154   -5.111
  148.129    9.658   -6.370   148.076   11.162   -7.628
  148.023   12.667   -8.887   147.971   14.171  -10.145
  147.918   15.675  -11.404   147.865   17.179  -12.662
  147.812   18.684  -13.921
  153.934    5.619   -3.256   153.881    7.123   -4.514
  153.828    8.627   -5.773   153.776   10.131   -7.031
  153.723   11.636   -8.290   153.670   13.140   -9.548
  153.617   14.644  -10.806   153.564   16.149  -12.065
  153.512   17.653  -13.323
  160.353    4.457   -2.583   160.301    5.962   -3.841
  160.248    7.466   -5.100   160.195    8.970   -6.358
  160.142   10.475   -7.617   160.089   11.979   -8.875
  160.036   13.483  -10.134   159.984   14.987  -11.392
  159.931   16.492  -12.651
 1160.353    4.457   -2.583  1160.301    5.962   -3.841
 1160.248    7.466   -5.100  1160.195    8.970   -6.358
 1160.142   10.475   -7.617  1160.089   11.979   -8.875
 1160.036   13.483  -10.134  1159.984   14.987  -11.392
 1159.931   16.492  -12.651
$POINTS NETWORK = ZCNBDWK4
1.0
18.0       1.        0.       0.        1.
      9.0     16.0
   45.236    2.324    3.138    45.183    3.583    4.642
   45.130    4.841    6.146    45.077    6.100    7.650
   45.025    7.358    9.155    44.972    8.616   10.659
   44.919    9.875   12.163    44.866   11.133   13.668
   44.813   12.392   15.172
   53.318    2.007    3.463    53.265    3.265    4.967
   53.212    4.523    6.471    53.160    5.782    7.976
   53.107    7.040    9.480    53.054    8.299   10.984
   53.001    9.557   12.489    52.948   10.816   13.993
   52.896   12.074   15.497
   61.785    3.185    5.497    61.732    4.444    7.001
   61.679    5.702    8.505    61.627    6.960   10.010
   61.574    8.219   11.514    61.521    9.477   13.018
   61.468   10.736   14.523    61.415   11.994   16.027
   61.362   13.253   17.531
   71.254    3.638    6.278    71.201    4.896    7.782
   71.148    6.155    9.286    71.096    7.413   10.790
   71.043    8.672   12.295    70.990    9.930   13.799
   70.937   11.189   15.303    70.884   12.447   16.808
   70.831   13.705   18.312
  132.459    3.638    6.278   132.406    4.896    7.782
```

1043	132.353	6.155	9.286	132.301	7.413	10.791
1044	132.248	8.672	12.295	132.195	9.930	13.799
1045	132.142	11.189	15.304	132.089	12.447	16.808
1046	132.036	13.705	18.312			
1047	134.175	3.795	6.549	134.122	5.054	8.054
1048	134.070	6.312	9.558	134.017	7.570	11.062
1049	133.964	8.829	12.566	133.911	10.087	14.071
1050	133.858	11.346	15.575	133.806	12.604	17.079
1051	133.753	13.863	18.583			
1052	135.865	3.950	6.817	135.812	5.208	8.321
1053	135.759	6.467	9.825	135.706	7.725	11.329
1054	135.653	8.984	12.834	135.600	10.242	14.338
1055	135.548	11.501	15.842	135.495	12.759	17.347
1056	135.442	14.018	18.851			
1057	137.500	4.100	7.075	137.447	5.358	8.580
1058	137.394	6.617	10.084	137.341	7.875	11.588
1059	137.288	9.134	13.092	137.236	10.392	14.597
1060	137.183	11.651	16.101	137.130	12.909	17.605
1061	137.077	14.168	19.109			
1062	138.947	4.195	7.240	138.895	5.454	8.744
1063	138.842	6.712	10.248	138.789	7.971	11.752
1064	138.736	9.229	13.257	138.683	10.488	14.761
1065	138.631	11.746	16.265	138.578	13.004	17.770
1066	138.525	14.263	19.274			
1067	140.100	4.254	7.341	140.048	5.512	8.845
1068	139.995	6.771	10.350	139.942	8.029	11.854
1069	139.889	9.288	13.358	139.836	10.546	14.863
1070	139.784	11.805	16.367	139.731	13.063	17.871
1071	139.678	14.322	19.375			
1072	141.551	4.328	7.469	141.498	5.586	8.973
1073	141.445	6.845	10.477	141.393	8.103	11.981
1074	141.340	9.362	13.486	141.287	10.620	14.990
1075	141.234	11.879	16.494	141.181	13.137	17.999
1076	141.129	14.396	19.503			
1077	143.975	4.299	7.420	143.923	5.558	8.924
1078	143.870	6.816	10.428	143.817	8.075	11.933
1079	143.764	9.333	13.437	143.711	10.592	14.941
1080	143.658	11.850	16.445	143.606	13.109	17.950
1081	143.553	14.367	19.454			
1082	148.235	3.853	6.649	148.182	5.111	8.154
1083	148.129	6.370	9.658	148.076	7.628	11.162
1084	148.023	8.887	12.667	147.971	10.145	14.171
1085	147.918	11.404	15.675	147.865	12.662	17.179
1086	147.812	13.921	18.684			
1087	153.934	3.256	5.619	153.881	4.514	7.123
1088	153.828	5.773	8.627	153.776	7.031	10.131
1089	153.723	8.290	11.636	153.670	9.548	13.140
1090	153.617	10.806	14.644	153.564	12.065	16.149
1091	153.512	13.323	17.653			
1092	160.353	2.583	4.457	160.301	3.841	5.962
1093	160.248	5.100	7.466	160.195	6.358	8.970
1094	160.142	7.617	10.475	160.089	8.875	11.979
1095	160.036	10.134	13.483	159.984	11.392	14.987
1096	159.931	12.651	16.492			
1097	1160.353	2.583	4.457	1160.301	3.841	5.962
1098	1160.248	5.100	7.466	1160.195	6.358	8.970
1099	1160.142	7.617	10.475	1160.089	8.875	11.979

```
1100   1160.036    10.134    13.483  1159.984    11.392    14.987
1101   1159.931    12.651    16.492
1102 $POINTS NETWORK =  ZBODWAK
1103 1.0
1104 18.          1.                             1.
1105        13.0        2.0
1106     160.353    -2.568     4.459   160.353     0.000     5.148
1107     160.353     2.568     4.460   160.353     4.457     2.583
1108     160.353     5.148     0.000   160.353     4.457    -2.583
1109     160.353     2.584    -4.458   160.353     0.000    -5.148
1110     160.353    -2.583    -4.458   160.353    -4.457    -2.584
1111     160.353    -5.148    -0.001   160.353    -4.457     2.583
1112     160.353    -2.568     4.459
1113    1160.353    -2.568     4.459  1160.353     0.000     5.148
1114    1160.353     2.568     4.460  1160.353     4.457     2.583
1115    1160.353     5.148     0.000  1160.353     4.457    -2.583
1116    1160.353     2.584    -4.458  1160.353     0.000    -5.148
1117    1160.353    -2.583    -4.458  1160.353    -4.457    -2.584
1118    1160.353    -5.148    -0.001  1160.353    -4.457     2.583
1119    1160.353    -2.568     4.459
1120 $END
1

                          record of input processing


$TIT
$SYM
$MAC
$CAS
$ANG
$PRI
$REF
$POI
    kn,kt              1         2
   network # being processed   1    9.0000    9.0000    0.0000    0.0000    0.0000    0.0000

$POI
    kn,kt              1         2
   network # being processed   2    9.0000    9.0000    0.0000    0.0000    0.0000    0.0000

$POI
    kn,kt              1         2
   network # being processed   3    9.0000    9.0000    0.0000    0.0000    0.0000    0.0000

$POI
    kn,kt              1         2
   network # being processed   4    9.0000    9.0000    0.0000    0.0000    0.0000    0.0000

$POI
    kn,kt              1         1
   network # being processed   5    4.0000   13.0000    0.0000    0.0000    0.0000    0.0000

$POI
    kn,kt              1         1
   network # being processed   6   13.0000    2.0000    0.0000    0.0000    0.0000    0.0000
```

APPENDIX B. GBU-24 OUPUT FILE (EDGE ANALYSIS)

Printed by maletour from osprey

Mar 7 1996 13:51 **results** Page 58

abutment	nw-ident	ntd	knet.edge	nw-ident	ntd	knet.edge	
1		12	1.1-		18	30.1+	
		18	30.1-		12	1.1+	
2		12	1.2-		12	1.2+	probable error: unabutted free edge
3		12	1.3-		12	1.3+	probable error: unabutted free edge
4		12	10.2-		12	11.4-	
		12	11.4+		12	1.4+	
		12	1.4-		12	10.2+	
5		12	2.1-		18	29.1+	
		18	29.1-		12	2.1+	
6		12	2.2-		12	2.2+	probable error: unabutted free edge
7		12	2.3-		12	2.3+	probable error: unabutted free edge
8		12	9.2-		12	10.4-	
		12	10.4+		12	2.4+	
		12	2.4-		12	9.2+	
9		12	3.1-		18	31.1+	
		18	31.1-		12	3.1+	
10		12	3.2-		12	3.2+	probable error: unabutted free edge
11		12	3.3-		12	3.3+	probable error: unabutted free edge
12		12	11.2-		12	8.4-	
		12	8.4+		12	3.4+	
		12	3.4-		12	11.2+	
13		12	4.1-		18	28.1+	
		18	28.1-		12	4.1+	
14		12	4.2-		12	4.2+	probable error: unabutted free edge
15		12	4.3-		12	4.3+	probable error: unabutted free edge
16		12	8.2-		12	9.4-	
		12	9.4+		12	4.4+	
		12	4.4-		12	8.2+	
17		12	6.4+		12	5.1+	
		12	5.1-		12	6.4-	
18		12	5.4+		12	5.2+	
		12	5.2-		12	5.4-	
19		12	6.3+		12	6.1+	
		12	6.1-		12	6.3-	
20		12	7.3+		12	6.2+	
		12	6.2-		12	7.3-	
21		12	7.3+		12	6.2+	
		12	6.2-		12	7.3-	
22		12	8.1+		12	7.1+	
		12	7.1-		12	8.1-	
23		12	7.1-		12	11.1-	
		12	11.1+		12	7.1+	
24		12	10.1+		12	7.1+	
		12	7.1-		12	10.1-	
25		12	9.1+		12	7.1+	
		12	7.1-		12	9.1-	
26		12	7.4+		12	7.2+	
		12	7.2-		12	7.4-	
27		12	12.2+		12	8.3+	
		12	8.3-		12	12.2-	
28		12	12.2+		12	9.3+	
		12	9.3-		12	12.2-	
29		12	12.2+		12	10.3+	
		12	10.3-		12	12.2-	
30		12	11.3-		12	12.2-	
		12	12.2+		12	11.3+	

58

31	12	12.3+	12	12.1+	
	12	12.1-	12	12.3-	
32	12	13.3+	12	12.4+	
	12	12.4-	12	13.3-	
33	12	13.3+	12	12.4+	
	12	12.4-	12	13.3-	
34	12	13.1-	12	14.3-	
	12	14.3+	12	13.1+	
35	12	13.1-	12	14.3-	
	12	14.3+	12	13.1+	
36	12	13.4+	12	13.2+	
	12	13.2-	12	13.4-	
37	12	14.1-	12	21.4-	
	12	21.4+	12	14.1+	
38	12	14.1-	12	17.4-	
	12	17.4+	12	14.1+	
39	12	14.1-	12	16.4-	
	12	16.4+	12	14.1+	
40	12	14.1-	12	15.4-	
	12	15.4+	12	14.1+	
41	12	14.4+	12	14.2+	
	12	14.2-	12	14.4-	
42	12	16.3+	12	19.4-	
	12	19.4+	12	15.1+	
	12	15.1-	12	16.3-	
43	12	23.4+	18	32.1+	
	18	32.1-	12	15.2+	
•	12	15.2-	12	23.4-	
44	12	21.1+	12	22.4+	
	12	22.4-	12	15.3+	
	12	15.3-	12	21.1-	
45	12	17.3+	12	20.4-	
	12	20.4+	12	16.1+	
	12	16.1-	12	17.3-	
46	12	23.4+	18	32.1+	
	18	32.1-	12	16.2+	
	12	16.2-	12	23.4-	
47	12	21.3+	12	18.4-	
	12	18.4+	12	17.1+	
	12	17.1-	12	21.3-	
48	12	23.4+	18	32.1+	
	18	32.1-	12	17.2+	
	12	17.2-	12	23.4-	
49	12	18.1-	12	18.1+	probable error: unabutted free edge
50	12	18.2-	12	18.2+	probable error: unabutted free edge
51	12	18.3-	18	24.1-	
	18	24.1+	12	18.3+	
52	12	19.1-	12	19.1+	probable error: unabutted free edge
53	12	19.2-	12	19.2+	probable error: unabutted free edge
54	12	19.3-	18	26.1-	
	18	26.1+	12	19.3+	
55	12	20.1-	12	20.1+	probable error: unabutted free edge
56	12	20.2-	12	20.2+	probable error: unabutted free edge
57	12	20.3-	18	27.1-	
	18	27.1+	12	20.3+	
58	12	23.4+	18	32.1+	
	18	32.1-	12	21.2+	

72

	12	21.2-	12	23.4-	
59	12	22.1-	12	22.1+	probable error: unabutted free edge
60	12	22.2-	12	22.2+	probable error: unabutted free edge
61	12	22.3-	18	25.1-	
	18	25.1+	12	22.3+	
62	12	23.1-	12	23.3-	
	12	23.3+	12	23.1+	
63	18	24.2-	18	24.2+	
64	18	24.3-	18	24.3+	
65	18	24.4-	18	24.4+	
66	18	25.2-	18	25.2+	
67	18	25.3-	18	25.3+	
68	18	32.2+	18	32.4+	
	18	32.4-	18	25.4+	
	18	25.4-	18	32.2-	
69	18	26.2-	18	26.2+	
70	18	26.3-	18	26.3+	
71	18	26.4-	18	26.4+	
72	18	27.2-	18	27.2+	
73	18	27.3-	18	27.3+	
74	18	27.4-	18	27.4+	
75	18	28.2-	18	28.2+	
76	18	28.3-	18	28.3+	
77	18	28.4-	18	28.4+	
78	18	29.2-	18	29.2+	
79	18	29.3-	18	29.3+	
80	18	29.4-	18	29.4+	
81	18	30.2-	18	30.2+	
82	18	30.3-	18	30.3+	
83	18	30.4-	18	30.4+	
84	18	31.2-	18	31.2+	
85	18	31.3-	18	31.3+	
86	18	31.4-	18	31.4+	
87	18	32.3-	18	32.3+	

surfaces associated with various regions of the configuration

region	nw-id	nw-name	dblt-type	surface	material		r/ctr	
1	1		analysis	upper	air	75.546633	0.341333	-0.739267
	1		analysis	lower	air			
	2		analysis	upper	air			
	2		analysis	lower	air			
	3		analysis	upper	air			
	3		analysis	lower	air			
	4		analysis	upper	air			
	4		analysis	lower	air			
	5		analysis	upper	air			
	6		analysis	upper	air			
	7		analysis	upper	air			
	8		analysis	upper	air			
	9		analysis	upper	air			
	10		analysis	upper	air			
	11		analysis	upper	air			
	12		analysis	upper	air			
	13		analysis	upper	air			
	14		analysis	upper	air			
	15		analysis	upper	air			

```
           16          analysis     upper    air
           17          analysis     upper    air
           18          analysis     upper    air
           18          analysis     lower    air
           19          analysis     upper    air
           19          analysis     lower    air
           20          analysis     upper    air
           20          analysis     lower    air
           21          analysis     upper    air
           22          analysis     upper    air
           22          analysis     lower    air
           24          nt=18 wake   upper    air
           24          nt=18 wake   lower    air
           25          nt=18 wake   upper    air
           25          nt=18 wake   lower    air
           26          nt=18 wake   upper    air
           26          nt=18 wake   lower    air
           27          nt=18 wake   upper    air
           27          nt=18 wake   lower    air
           28          nt=18 wake   upper    air
           28          nt=18 wake   lower    air
           29          nt=18 wake   upper    air
           29          nt=18 wake   lower    air
           30          nt=18 wake   upper    air
           30          nt=18 wake   lower    air
           31          nt=18 wake   upper    air
           31          nt=18 wake   lower    air
           32          nt=18 wake   lower    air

     2      5          analysis     lower    air        68.013867    0.854933   -1.775733
            6          analysis     lower    air
            7          analysis     lower    air
            8          analysis     lower    air
            9          analysis     lower    air
           10          analysis     lower    air
           11          analysis     lower    air
           12          analysis     lower    air
           13          analysis     lower    air
           14          analysis     lower    air
           15          analysis     lower    air
           16          analysis     lower    air
           17          analysis     lower    air
           21          analysis     lower    air
           23          analysis     lower    air

     3     23          analysis     upper    air       160.353000    2.584000   -4.458000
           32          nt=18 wake   upper    air

0*b*extra-cp

0 *****  summary of extra control points  *****

        nw  edge  point  row  col   fine grid location
   1.    6     2     11   11    2     21    3
   2.    7     1      4    1    4      1    7
   3.    7     1      7    1    7      1   13
```

74

```
     4.   7     1     10    1   10       1   19
     5.   7     3     11    3    3       5    5
     6.  12     2      4    4    3       7    5
     7.  12     2      7    7    3      13    5
     8.  12     2     10   10    3      19    5
     9.  12     4      3   11    1      21    1
    10.  13     1     12    1   12       1   23
    11.  13     3      3    2   11       3   21
    12.  14     1      4    1    4       1    7
    13.  14     1      7    1    7       1   13
    14.  14     1     10    1   10       1   19
    15.  14     3     12    4    2       7    3
    16.  23     4      4   10    1      19    1
    17.  23     4      7    7    1      13    1
    18.  23     4     10    4    1       7    1
    19.  32     1      4    1    4       1    7
    20.  32     1      7    1    7       1   13
    21.  32     1     10    1   10       1   19
0*e*extra-cp
0*b*extra-vp

0 *****  summary of extra v-parameter points  *****

         nw   edge  point  row  col     fine grid location
     1.   6     2     11   11    2      21    3
     2.   7     1      4    1    4       1    7
     3.   7     1      7    1    7       1   13
     4.   7     1     10    1   10       1   19
     5.   7     3     11    3    3       5    5
     6.  12     2      4    4    3       7    5
     7.  12     2      7    7    3      13    5
     8.  12     2     10   10    3      19    5
     9.  12     4      3   11    1      21    1
    10.  13     1     12    1   12       1   23
    11.  13     3      3    2   11       3   21
    12.  14     1      4    1    4       1    7
    13.  14     1      7    1    7       1   13
    14.  14     1     10    1   10       1   19
    15.  14     3     12    4    2       7    3
    16.  23     4      4   10    1      19    1
    17.  23     4      7    7    1      13    1
    18.  23     4     10    4    1       7    1
    19.  32     1      4    1    4       1    7
    20.  32     1      7    1    7       1   13
    21.  32     1     10    1   10       1   19
0*e*extra-vp
0*b*abutment
1                                 abutment summary


0abutment #   1
                   dblt edge                          starts at ai #   1      ends at ai #   2
  nw.edge  nw/id   type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
   1.1              12    4                              1   2   3   4   5   6   7   8   9
  30.1              18    5   mu-match                   1   2   3   4   5   6   7   8   9
0abutment #   2    doublet strength matched to zero along this abutment                                  ***  warning  **
```

```
 *
                      dblt edge                       starts at ai #   2      ends at ai #   3
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   1.2              12    4   mu-match                1   2   3   4   5   6   7   8   9
0abutment #   3     doublet strength matched to zero along this abutment                           ***  warning  **
 *
                      dblt edge                       starts at ai #   3      ends at ai #   4
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   1.3              12    4   mu-match                1   2   3   4   5   6   7   8   9
0abutment #   4
                      dblt edge                       starts at ai #   1      ends at ai #   4
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   1.4              12    4   mu-match                1   2   3   4   5   6   7   8   9
  10.2              12    4                           1   0   0   0   0   0   0   0   2
  11.4              12    4                           2   0   0   0   0   0   0   0   1
0abutment #   5
                      dblt edge                       starts at ai #   5      ends at ai #   6
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   2.1              12    4                           1   2   3   4   5   6   7   8   9
  29.1              18    5   mu-match                1   2   3   4   5   6   7   8   9
0abutment #   6     doublet strength matched to zero along this abutment                           ***  warning  **
 *
                      dblt edge                       starts at ai #   6      ends at ai #   7
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   2.2              12    4   mu-match                1   2   3   4   5   6   7   8   9
0abutment #   7     doublet strength matched to zero along this abutment                           ***  warning  **
 *
                      dblt edge                       starts at ai #   7      ends at ai #   8
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   2.3              12    4   mu-match                1   2   3   4   5   6   7   8   9
0abutment #   8
                      dblt edge                       starts at ai #   5      ends at ai #   8
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   2.4              12    4   mu-match                1   2   3   4   5   6   7   8   9
   9.2              12    4                           1   0   0   0   0   0   0   0   2
  10.4              12    4                           2   0   0   0   0   0   0   0   1
0abutment #   9
                      dblt edge                       starts at ai #   9      ends at ai #  10
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   3.1              12    4                           1   2   3   4   5   6   7   8   9
  31.1              18    5   mu-match                1   2   3   4   5   6   7   8   9
0abutment #  10     doublet strength matched to zero along this abutment                           ***  warning  **
 *
                      dblt edge                       starts at ai #  10      ends at ai #  11
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   3.2              12    4   mu-match                1   2   3   4   5   6   7   8   9
0abutment #  11     doublet strength matched to zero along this abutment                           ***  warning  **
 *
                      dblt edge                       starts at ai #  11      ends at ai #  12
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   3.3              12    4   mu-match                1   2   3   4   5   6   7   8   9
0abutment #  12
                      dblt edge                       starts at ai #  12      ends at ai #   9
  nw.edge  nw/id   type type  matching  kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
   3.4              12    4   mu-match                1   2   3   4   5   6   7   8   9
   8.4              12    4                           2   0   0   0   0   0   0   0   1
  11.2              12    4                           1   0   0   0   0   0   0   0   2
```

```
0abutment #  13
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  13      ends at ai #  14
   4.1                     12    4                             corresponding edge points ( minus (-) indicates point moved by $eat
   28.1                    18    5     mu-match                  1   2   3   4   5   6   7   8   9
0abutment #  14                                                  1   2   3   4   5   6   7   8   9
*                         doublet strength matched to zero along this abutment
                                                                                                      *** warning **
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  14      ends at ai #  15
   4.2                     12    4     mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  15                                                  1   2   3   4   5   6   7   8   9
*                         doublet strength matched to zero along this abutment
                                                                                                      *** warning **
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  15      ends at ai #  16
   4.3                     12    4     mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  16                                                  1   2   3   4   5   6   7   8   9
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  13      ends at ai #  16
   4.4                     12    4     mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
   8.2                     12    4                               1   2   3   4   5   6   7   8   9
   9.4                     12    4                               1   0   0   0   0   0   0   0   2
0abutment #  17                                                  2   0   0   0   0   0   0   0   1
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  17      ends at ai #  17
   5.1                     12    4                             corresponding edge points ( minus (-) indicates point moved by $eat
   6.4                     12    4     mu-match                  1   2   3   4   5   6   7   8   9  10  11  12  13
0abutment #  18                                                 13  12  11  10   9   8   7   6   5   4   3   2   1
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  18      ends at ai #  17
   5.2                     12    4     mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
   5.4                     12    4                               1  -2   3   4
0abutment #  19                                                  4  -3   2   1
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  19      ends at ai #  17
   6.1                     12    4     mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
   6.3                     12    4                               1   2
0abutment #  20                                                  2   1
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  20      ends at ai #  19
   6.2                     12    4                             corresponding edge points ( minus (-) indicates point moved by $eat
   7.3                     12    4     mu-match                  1   2   3   4   5   6   7   8   9  10  11
0abutment #  21                                                 11  10   9   8   7   6   5   4   3   2   1
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  19      ends at ai #  20
   6.2                     12    4                             corresponding edge points ( minus (-) indicates point moved by $eat
   7.3                     12    4     mu-match                 11  12  13
0abutment #  22                                                 13  12  11
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #  12      ends at ai #  16
   7.1                     12    4                             corresponding edge points ( minus (-) indicates point moved by $eat
   8.1                     12    4     mu-match                  1   2   3   4
0abutment #  23                                                  4   3   2   1
                          dblt edge
  nw.edge   nw/id         type type   matching   kutta-fl      starts at ai #   4      ends at ai #  12
   7.1                     12    4                             corresponding edge points ( minus (-) indicates point moved by $eat
   11.1                    12    4     mu-match                  4   5   6   7
0abutment #  24                                                  4   3   2   1
```

```
                    dblt edge                    starts at ai #   8      ends at ai #   4
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  7.1               12    4                        7    8    9   10
 10.1               12    4     mu-match           4    3    2    1
0abutment #  25
                    dblt edge                    starts at ai #  16      ends at ai #   8
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  7.1               12    4                       10   11   12   13
  9.1               12    4     mu-match           4    3    2    1
0abutment #  26
                    dblt edge                    starts at ai #  20      ends at ai #  16
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  7.2               12    4     mu-match           1    2    3
  7.4               12    4                        3    2    1
0abutment #  27
                    dblt edge                    starts at ai #   9      ends at ai #  13
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  8.3               12    4                        1    2    3    4
 12.2               12    4     mu-match          13   12   11   10
0abutment #  28
                    dblt edge                    starts at ai #  13      ends at ai #   5
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  9.3               12    4                        1    2    3    4
 12.2               12    4     mu-match           4    3    2    1
0abutment #  29
                    dblt edge                    starts at ai #   5      ends at ai #   1
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
 10.3               12    4                        1    2    3    4
 12.2               12    4     mu-match           7    6    5    4
0abutment #  30
                    dblt edge                    starts at ai #   1      ends at ai #   9
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
 11.3               12    4                        1    2    3    4
 12.2               12    4     mu-match          10    9    8    7
0abutment #  31
                    dblt edge                    starts at ai #  13      ends at ai #  21
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
 12.1               12    4                        1    2    3
 12.3               12    4     mu-match           3    2    1
0abutment #  32
                    dblt edge                    starts at ai #  22      ends at ai #  21
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
 12.4               12    4                        1    2    3
 13.3               12    4     mu-match           3    2    1
0abutment #  33
                    dblt edge                    starts at ai #  21      ends at ai #  22
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
 12.4               12    4                        3    4    5    6    7    8    9   10   11   12   13
 13.3               12    4     mu-match          13   12   11   10    9    8    7    6    5    4    3
0abutment #  34
                    dblt edge                    starts at ai #  24      ends at ai #  23
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
 13.1               12    4                        1    2    3    4    5    6    7    8    9   10   11   12
 14.3               12    4     mu-match          12   11   10    9    8    7    6    5    4    3    2    1
0abutment #  35
                    dblt edge                    starts at ai #  23      ends at ai #  24
nw.edge   nw/id     type type   matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
```

```
  13.1             12    4                            12  13
  14.3             12    4   mu-match                 13  12
 0abutment #  36
                  dblt edge                          starts at ai #  22      ends at ai #  23
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  13.2             12    4   mu-match                 1   2
  13.4             12    4                            2   1
 0abutment #  37
                  dblt edge                          starts at ai #  26      ends at ai #  25
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  14.1             12    4                            1   2   3   4
  21.4             12    4   mu-match                 4   3   2   1
 0abutment #  38
                  dblt edge                          starts at ai #  27      ends at ai #  26
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  14.1             12    4                            4   5   6   7
  17.4             12    4   mu-match                 4   3   2   1
 0abutment #  39
                  dblt edge                          starts at ai #  28      ends at ai #  27
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  14.1             12    4                            7  -8   9  10
  16.4             12    4   mu-match                 4  -3   2   1
 0abutment #  40
                  dblt edge                          starts at ai #  25      ends at ai #  28
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  14.1             12    4                           10 -11  12  13
  15.4             12    4   mu-match                 4  -3   2   1
 0abutment #  41
                  dblt edge                          starts at ai #  24      ends at ai #  25
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  14.2             12    4                            1   2   3   4
  14.4             12    4   mu-match                 4   3   2   1
 0abutment #  42
                  dblt edge                          starts at ai #  29      ends at ai #  28
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  15.1             12    4   mu-match                 1   2   3   4   5   6   7   8   9  10  11
  16.3             12    4                           11  10   9   8   7   6   5   4   3   2   1
  19.4             12    4                           11  10   9   8   7   6   5   4   3   2   1
 0abutment #  43
                  dblt edge                          starts at ai #  29      ends at ai #  30
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  15.2             12    4                            1  -2   3   4
  23.4             12    4                            4  -3   2   1
  32.1             18    5   mu-match                10 -11  12  13
 0abutment #  44
                  dblt edge                          starts at ai #  30      ends at ai #  25
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  15.3             12    4                            1   2   3   4   5  -6  -7   8   9 -10  11
  21.1             12    4   mu-match                11  10   9   8   7  -6  -5   4   3  -2   1
  22.4             12    4                            1   2   3   4   5  -6  -7   8   9 -10  11
 0abutment #  45
                  dblt edge                          starts at ai #  31      ends at ai #  27
  nw.edge  nw/id  type type  matching  kutta-fl      corresponding edge points ( minus (-) indicates point moved by $eat
  16.1             12    4                            1   2   3   4   5   6   7   8   9  10  11
  17.3             12    4   mu-match                11  10   9   8   7   6   5   4   3   2   1
  20.4             12    4                           11  10   9   8   7   6   5   4   3   2   1
 0abutment #  46
```

```
                      dblt edge                          starts at ai #  31      ends at ai #  29
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  16.2                 12    4                             1   2   3   4
  23.4                 12    4                             7   6   5   4
  32.1                 18    5    mu-match                 7   8   9  10
0abutment #  47
                      dblt edge                          starts at ai #  32      ends at ai #  26
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  17.1                 12    4                             1  -2   3   4  -5  -6   7   8   9  10  11
  18.4                 12    4                            11 -10   9   8  -7  -6   5   4   3   2   1
  21.3                 12    4    mu-match                11 -10   9   8  -7  -6   5   4   3   2   1
0abutment #  48
                      dblt edge                          starts at ai #  32      ends at ai #  31
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  17.2                 12    4                             1   2   3   4
  23.4                 12    4                            10   9   8   7
  32.1                 18    5    mu-match                 4   5   6   7
0abutment #  49    doublet strength matched to zero along this abutment                                   *** warning **
*
                      dblt edge                          starts at ai #  26      ends at ai #  33
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  18.1                 12    4    mu-match                 1   2   3   4   5   6   7
0abutment #  50    doublet strength matched to zero along this abutment                                   *** warning **
*
                      dblt edge                          starts at ai #  33      ends at ai #  34
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  18.2                 12    4    mu-match                 1   2   3   4   5   6   7   8   9  10  11
0abutment #  51
                      dblt edge                          starts at ai #  32      ends at ai #  34
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  18.3                 12    4    vor-mtch                 1   2   3   4   5   6   7
  24.1                 18    5    mu-match   vor-mtch      7   6   5   4   3   2   1
0abutment #  52    doublet strength matched to zero along this abutment                                   *** warning **
*
                      dblt edge                          starts at ai #  28      ends at ai #  35
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  19.1                 12    4    mu-match                 1   2   3   4   5   6   7
0abutment #  53    doublet strength matched to zero along this abutment                                   *** warning **
*
                      dblt edge                          starts at ai #  35      ends at ai #  36
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  19.2                 12    4    mu-match                 1   2   3   4   5   6   7   8   9  10  11
0abutment #  54
                      dblt edge                          starts at ai #  29      ends at ai #  36
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  19.3                 12    4    vor-mtch                 1   2   3   4   5   6   7
  26.1                 18    5    mu-match   vor-mtch      7   6   5   4   3   2   1
0abutment #  55    doublet strength matched to zero along this abutment                                   *** warning **
*
                      dblt edge                          starts at ai #  27      ends at ai #  37
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  20.1                 12    4    mu-match                 1   2   3   4   5   6   7
0abutment #  56    doublet strength matched to zero along this abutment                                   *** warning **
*
                      dblt edge                          starts at ai #  37      ends at ai #  38
  nw.edge   nw/id     type type   matching   kutta-fl    corresponding edge points ( minus (-) indicates point moved by $eat
  20.2                 12    4    mu-match                 1   2   3   4   5   6   7   8   9  10  11
```

```
0abutment #  57
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  31      ends at ai #  38
   20.3               12    4    vor-mtch                corresponding edge points ( minus (-) indicates point moved by $eat
   27.1               18    5    mu-match   vor-mtch        1    2    3    4    5    6    7
0abutment #  58                                             7    6    5    4    3    2    1
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  30      ends at ai #  32
   21.2               12    4                            corresponding edge points ( minus (-) indicates point moved by $eat
   23.4               12    4                               1   -2    3    4
   32.1               18    5    mu-match                  13  -12   11   10
0abutment #  59       doublet strength matched to zero along this abutment
                                                            1   -2    3    4
*                                                                                                   ***  warning  **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  25      ends at ai #  39
   22.1               12    4    mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  60       doublet strength matched to zero along this abutment
                                                            1    2    3    4    5    6    7
*                                                                                                   ***  warning  **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  39      ends at ai #  40
   22.2               12    4    mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  61                                             1    2    3    4    5    6    7    8    9   10   11
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  30      ends at ai #  40
   22.3               12    4    vor-mtch                corresponding edge points ( minus (-) indicates point moved by $eat
   25.1               18    5    mu-match   vor-mtch        1    2    3    4    5    6    7
0abutment #  62                                             7    6    5    4    3    2    1
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  41      ends at ai #  30
   23.1               12    4    mu-match                corresponding edge points ( minus (-) indicates point moved by $eat
   23.3               12    4                               1    2
0abutment #  63       wake side edge left unabutted         2    1
*                                                                                                   ***  warning  **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  34      ends at ai #  42
   24.2               18    2                            corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  64       wake trailing edge unabutted.         1    2
                                                         wake filaments will be added
*                                                                                           *** gentle reminder **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  42      ends at ai #  43
   24.3               18    2                            corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  65       wake side edge left unabutted         1    2    3    4    5    6    7
*                                                                                                   ***  warning  **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  43      ends at ai #  32
   24.4               18    2                            corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  66       wake side edge left unabutted         1    2
*                                                                                                   ***  warning  **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  40      ends at ai #  44
   25.2               18    2                            corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  67       wake trailing edge unabutted.         1    2
                                                         wake filaments will be added
*                                                                                           *** gentle reminder **
                     dblt edge
  nw.edge   nw/id    type type   matching   kutta-fl     starts at ai #  44      ends at ai #  45
   25.3               18    2                            corresponding edge points ( minus (-) indicates point moved by $eat
0abutment #  68                                             1    2    3    4    5    6    7
```

```
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  25.4              18    2
  32.2              18    2
  32.4              18    2
0abutment #   69    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  26.2              18    2
0abutment #   70    wake trailing edge unabutted.
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  26.3              18    2
0abutment #   71    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  26.4              18    2
0abutment #   72    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  27.2              18    2
0abutment #   73    wake trailing edge unabutted.
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  27.3              18    2
0abutment #   74    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  27.4              18    2
0abutment #   75    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  28.2              18    2
0abutment #   76    wake trailing edge unabutted.
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  28.3              18    2
0abutment #   77    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  28.4              18    2
0abutment #   78    wake side edge left unabutted
*
 nw.edge   nw/id   dblt edge
                   type type   matching   kutta-fl
  29.2              18    2
0abutment #   79    wake trailing edge unabutted.
*
```

```
starts at ai #  45      ends at ai #  30
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2
   2   1
   1   2                                                 ***  warning  **

starts at ai #  36      ends at ai #  46
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2                                       *** gentle reminder **
wake filaments will be added

starts at ai #  46      ends at ai #  47
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2   3   4   5   6   7                             ***  warning  **

starts at ai #  47      ends at ai #  29
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2                                                 ***  warning  **

starts at ai #  38      ends at ai #  48
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2                                       *** gentle reminder **
wake filaments will be added

starts at ai #  48      ends at ai #  49
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2   3   4   5   6   7                             ***  warning  **

starts at ai #  49      ends at ai #  31
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2                                                 ***  warning  **

starts at ai #  14      ends at ai #  50
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
                                               *** gentle reminder **
wake filaments will be added

starts at ai #  50      ends at ai #  51
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2   3   4   5   6   7   8   9                     ***  warning  **

starts at ai #  51      ends at ai #  13
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
                                                         ***  warning  **

starts at ai #   6      ends at ai #  52
corresponding edge points ( minus (-) indicates point moved by $eat
   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
                                               *** gentle reminder **
wake filaments will be added
```

```
                   dblt edge                     starts at ai #  52      ends at ai #  53
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  29.3             18    2                           1   2   3   4   5   6   7   8   9
0abutment #  80     wake side edge left unabutted                                                     ***  warning  **
*
                   dblt edge                     starts at ai #  53      ends at ai #   5
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  29.4             18    2                           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
0abutment #  81     wake side edge left unabutted                                                     ***  warning  **
*
                   dblt edge                     starts at ai #   2      ends at ai #  54
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  30.2             18    2                           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
0abutment #  82     wake trailing edge unabutted.  wake filaments will be added                  *** gentle reminder **
*
                   dblt edge                     starts at ai #  54      ends at ai #  55
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  30.3             18    2                           1   2   3   4   5   6   7   8   9
0abutment #  83     wake side edge left unabutted                                                     ***  warning  **
*
                   dblt edge                     starts at ai #  55      ends at ai #   1
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  30.4             18    2                           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
0abutment #  84     wake side edge left unabutted                                                     ***  warning  **
*
                   dblt edge                     starts at ai #  10      ends at ai #  56
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  31.2             18    2                           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
0abutment #  85     wake trailing edge unabutted.  wake filaments will be added                  *** gentle reminder **
*
                   dblt edge                     starts at ai #  56      ends at ai #  57
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  31.3             18    2                           1   2   3   4   5   6   7   8   9
0abutment #  86     wake side edge left unabutted                                                     ***  warning  **
*
                   dblt edge                     starts at ai #  57      ends at ai #   9
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  31.4             18    2                           1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
0abutment #  87     wake trailing edge unabutted.  wake filaments will be added                  *** gentle reminder **
*
                   dblt edge                     starts at ai #  45      ends at ai #  45
  nw.edge  nw/id   type type  matching  kutta-fl  corresponding edge points ( minus (-) indicates point moved by $eat
  32.3             18    2                           1   2   3   4   5   6   7   8   9  10  11  12  13
0*e*abutment
0*b*nwedgmov
1          *****  movement of network edge points  *****
  nw.edge         motion
  dz(max)          dz(i)


    5.2       ** .lt. eps **      tolerance =   0.1911E-02
    0.50E-03    0.000000    0.000500    0.000000    0.000000
    1 orig x    8.499000    2.498000    0.482000    0.000000
           y    0.000000    0.000000    0.000000    0.000000
           z    3.999000    3.565000    1.853000    0.000000
     moved x    8.499000    2.498000    0.482000    0.000000
           y    0.000000    0.000000    0.000000    0.000000
```

APPENDIX C. GBU-24 OUTPUT FILE (UNIT NORMALS)

Printed by maletour from osprey


```
 nwltrf/in              9
       1.           24       25        26        27        28        29        30        31        32


 =====  summary of networks for trefftz plane analysis  =====

   nw    network-id
   ---   ----------
 nwltrf/out             9
       1.           24       25        26        27        28        29        30        31        32

   24
   25
   26
   27
   28
   29
   30
   31
   32

   t/abtidn     2.099325
  abtcal/anl    0.000034
 0*e*libgeoab
 0 control points for network :   1
     jc  jc/naive              zc                                    znc                  nw panel.sp jzc ifn jfn izdc abut fseg  ta
 u
     1    1   45.090395   3.246673  -2.414971  0.000000  0.641888  0.766799   1   1.1    1   1   1   1    1    1 0.0
 000
     2    2   43.834818   3.232000  -2.402644  0.000149  0.641734  0.766927   1   1.8    2   2   1   4    4    4 0.9
 375
     3    3   41.158462   3.232000  -2.402625  0.000000  0.641588  0.767049   1   2.8    3   4   1   4    4    4 0.8
 125
     4    4   38.481511   3.232000  -2.402625  0.000000  0.641588  0.767049   1   3.8    4   6   1   4    4    4 0.6
 875
     5    5   35.804544   3.232000  -2.402580  0.000149  0.641392  0.767213   1   4.8    5   8   1   4    4    4 0.5
 625
     6    6   33.127182   3.232000  -2.402562  0.000000  0.641288  0.767301   1   5.8    6  10   1   4    4    4 0.4
 375
     7    7   30.449590   3.232000  -2.402562  0.000000  0.641288  0.767301   1   6.8    7  12   1   4    4    4 0.3
 125
     8    8   27.771476   3.232000  -2.402515  0.000149  0.641050  0.767499   1   7.8    8  14   1   4    4    4 0.1
 875
     9    9   25.093237   3.230462  -2.401216  0.000000  0.640987  0.767552   1   8.8    9  16   1   4    4    4 0.0
 625
    10   10   24.013415   3.231929  -2.402441  0.000000  0.640987  0.767552   1   8.4   10  17   1   5    3    3 1.0
 000
    11   11   45.085496   3.858495  -2.927114  0.000149  0.641734  0.766927   1   1.5   11   1   2  -1    0    1 0.0
 625
    12   12   43.930127   3.885736  -2.949683  0.000149  0.641734  0.766927   1   1.5   12   2   2   0    0    0 0.0
 000
    13   13   41.359743   3.885756  -2.949450  0.000000  0.641588  0.767049   1   2.5   13   4   2   0    0    0 0.0
 000
    14   14   38.789418   3.885803  -2.949489  0.000000  0.641588  0.767049   1   3.5   14   6   2   0    0    0 0.0
 000
    15   15   36.219655   3.885870  -2.949298  0.000149  0.641392  0.767213   1   4.5   15   8   2   0    0    0 0.0
```

76

APPENDIX D. GBU-24 OUTPUT FILE (SOLUTION DATA)

Printed by maletour from osprey


```
pic counts                                  panel/source  panel/doublet   block/source  block/doublet

no influence                                      0             0               0             0
monopole far field                           140654        614894               0             0
dipole far field                              68550        341612               0             0
quadrupole far field                          35875        148773               0             0
one sub-panel intermediate field              32254        120038               0             0
two sub-panel intermediate field              25193        141840               0             0
eight sub-panel near field                     1890          6943               0             0



                  influence coefficient generation i/o count
 ncalg=        0   nwrdg=           0   ncalt=        0   nwrdt=          0
  n56chg:                4
     1.            0       16313       112589       16313

0logical flags for cp/2 iteration:
        F = bkprnt, print flag for solver statistics
  wopen call on unit   19  blocks:   100   status:     0
0
               ***********************************
               *                                 *
               *      condition indicators       *
               *                                 *
               *  uniform solution 0.257794E-12  *
               *                                 *
               ***********************************
1
0*b*solution
                                        simultaneous solution number    1


 mach number =   0.80000    angle of attack =   2.00000    sideslip angle =   0.00000    freestream speed =   1.00000
 compressibility factor =   0.60000   compressibility angle of attack =   2.00000   compressibility angle of sideslip =   0.000
00
 freestream velocity = (   0.99939,   0.00000,   0.03490)    compressibility direction = (   0.99939,   0.00000,   0.03490)
1
    network id:             index:   1   source type =  0    doublet type = 12      number rows =   8    number columns =   8

  jc   ip        x          y          z          d0         dx         dy         dz         s0         anx        any        a
nz
  lmachu        wxu        wyu        wzu        pheu       vxu        vyu        vzu        cplinu     cpslnu     cp2ndu     cpi
snu
  lmachl        wxl        wyl        wzl        phel       vxl        vyl        vzl        cplinl     cpslnl     cp2ndl     cpi
snl
     wnu        wnl        pwnu       pwnl       vtu        vtl        pvtu       pvtl       cplind     cpslnd     cp2ndd     cpi
snd

   12    1    43.9301     3.8857    -2.9497     0.4701    -0.0365     0.1604    -0.1352     0.0000     0.0000     0.0196     0
.0234
     0.7580     0.9818     0.0789    -0.0662    -0.6205     0.9443     0.0789    -0.0675     0.1172     0.1009     0.0997     0
```

```
.0990
     0.7889    0.9920   -0.0815    0.0680   -1.0905    0.9809   -0.0815    0.0676    0.0348    0.0270    0.0269    0
.0268
     0.0000    0.0000   -0.0269   -0.0269    0.9500    0.9866    0.1377    0.0856    0.0825    0.0739    0.0728    0
.0722

  13      2   41.3597    3.8858   -2.9495    0.5707   -0.0349    0.0896   -0.0757    0.0000    0.0000    0.0196    0
.0234
     0.7630    0.9851    0.0430   -0.0360   -0.4911    0.9554    0.0430   -0.0370    0.0930    0.0862    0.0854    0
.0851
     0.7932    0.9960   -0.0465    0.0389   -1.0617    0.9903   -0.0465    0.0387    0.0179    0.0157    0.0157    0
.0157
     0.0000    0.0000   -0.0268   -0.0268    0.9571    0.9921    0.0905    0.0392    0.0750    0.0704    0.0697    0
.0694

  14      3   38.7894    3.8858   -2.9495    0.6353   -0.0168    0.0389   -0.0330    0.0000    0.0000    0.0196    0
.0234
     0.7731    0.9896    0.0174   -0.0145   -0.3976    0.9691    0.0174   -0.0152    0.0641    0.0614    0.0610    0
.0609
     0.7878    0.9949   -0.0216    0.0181   -1.0330    0.9859   -0.0216    0.0177    0.0281    0.0274    0.0273    0
.0273
     0.0000    0.0000   -0.0268   -0.0268    0.9694    0.9863    0.0546    0.0146    0.0359    0.0340    0.0337    0
.0336

  15      4   36.2197    3.8859   -2.9493    0.6558    0.0012    0.0043   -0.0036    0.0000    0.0000    0.0196    0
.0234
     0.7824    0.9932   -0.0004    0.0002   -0.3345    0.9801   -0.0004   -0.0003    0.0410    0.0398    0.0397    0
.0396
     0.7814    0.9927   -0.0048    0.0038   -0.9903    0.9790   -0.0048    0.0033    0.0431    0.0421    0.0419    0
.0419
     0.0000    0.0000   -0.0269   -0.0269    0.9801    0.9790    0.0294    0.0263   -0.0021   -0.0023   -0.0023   -0
.0023

  16      5   33.6500    3.8860   -2.9491    0.6287    0.0201   -0.0166    0.0143    0.0000    0.0000    0.0196    0
.0234
     0.7916    0.9967   -0.0114    0.0095   -0.2984    0.9905   -0.0114    0.0093    0.0196    0.0189    0.0188    0
.0188
     0.7739    0.9898    0.0051   -0.0043   -0.9271    0.9704    0.0051   -0.0050    0.0608    0.0592    0.0589    0
.0589
     0.0000    0.0000   -0.0268   -0.0268    0.9906    0.9704    0.0118    0.0414   -0.0411   -0.0404   -0.0401   -0
.0400

  17      6   31.0801    3.8861   -2.9492    0.5518    0.0400   -0.0253    0.0220    0.0000    0.0000    0.0196    0
.0234
     0.8008    1.0003   -0.0168    0.0140   -0.2883    1.0005   -0.0168    0.0140   -0.0008   -0.0015   -0.0015   -0
.0015
     0.7654    0.9863    0.0085   -0.0071   -0.8401    0.9606    0.0085   -0.0080    0.0806    0.0788    0.0782    0
.0782
     0.0000    0.0000   -0.0268   -0.0268    1.0007    0.9606    0.0012    0.0516   -0.0814   -0.0803   -0.0797   -0
.0797

  18      7   28.5100    3.8862   -2.9490    0.4202    0.0661   -0.0279    0.0248    0.0000    0.0000    0.0196    0
.0234
     0.8131    1.0051   -0.0197    0.0162   -0.3060    1.0140   -0.0197    0.0166   -0.0280   -0.0287   -0.0288   -0
.0288
     0.7545    0.9818    0.0082   -0.0070   -0.7263    0.9479    0.0082   -0.0082    0.1060    0.1042    0.1032    0
.1031
```

```
      0.0000     0.0000    -0.0269    -0.0269     1.0143     0.9479     0.0150     0.0617    -0.1339    -0.1329    -0.1320    -0
.1318

    19     8    25.9399     3.8863    -2.9489     0.2091     0.1259    -0.0564     0.0500     0.0000     0.0000     0.0195     0
.0234
      0.8428     1.0159    -0.0363     0.0303    -0.3655     1.0449    -0.0363     0.0313    -0.0908    -0.0921    -0.0929    -0
.0928
      0.7307     0.9716     0.0201    -0.0168    -0.5745     0.9190     0.0201    -0.0186     0.1644     0.1614     0.1589     0
.1585
      0.0000     0.0000    -0.0268    -0.0268     1.0460     0.9194     0.0522     0.0945    -0.2551    -0.2535    -0.2518    -0
.2513

    22     9    43.9956     5.3899    -4.2081     0.6121    -0.0103     0.0309    -0.0261     0.0000     0.0000     0.0178     0
.0212
      0.7641     0.9858     0.0114    -0.0099    -0.5134     0.9589     0.0114    -0.0109     0.0841     0.0820     0.0813     0
.0812
      0.7731     0.9890    -0.0195     0.0159    -1.1255     0.9693    -0.0195     0.0152     0.0616     0.0609     0.0605     0
.0605
      0.0000     0.0000    -0.0271    -0.0271     0.9591     0.9696     0.0555     0.0302     0.0225     0.0211     0.0208     0
.0207

    23    10    41.6628     5.3899    -4.2076     0.6418    -0.0113     0.0155    -0.0132     0.0000     0.0000     0.0178     0
.0212
      0.7708     0.9885     0.0025    -0.0021    -0.4271     0.9668     0.0025    -0.0028     0.0678     0.0664     0.0660     0
.0660
      0.7807     0.9923    -0.0130     0.0109    -1.0689     0.9781    -0.0130     0.0104     0.0442     0.0435     0.0433     0
.0433
      0.0000     0.0000    -0.0268    -0.0268     0.9668     0.9783     0.0418     0.0220     0.0236     0.0230     0.0227     0
.0227
1
   network id:            index:   1   source type =  0    doublet type = 12     number rows =   8   number columns =   8

   jc   ip         x          y          z         d0         dx         dy         dz         s0        anx        any         a
nz
  lmachu          wxu        wyu        wzu        pheu       vxu        vyu        vzu       cplinu     cpslnu     cp2ndu       cpi
snu
  lmachl          wxl        wyl        wzl        phel       vxl        vyl        vzl       cplinl     cpslnl     cp2ndl       cpi
snl
     wnu          wnl        pwnu       pwnl       vtu        vtl        pvtu       pvtl      cplind     cpslnd     cp2ndd       cpi
snd

    24    11    39.3297     5.3900    -4.2074     0.6593    -0.0025     0.0030    -0.0026     0.0000     0.0000     0.0178     0
.0212
      0.7787     0.9917    -0.0043     0.0034    -0.3620     0.9760    -0.0043     0.0028     0.0490     0.0480     0.0478     0
.0478
      0.7810     0.9925    -0.0073     0.0059    -1.0213     0.9785    -0.0073     0.0054     0.0438     0.0429     0.0427     0
.0427
      0.0000     0.0000    -0.0269    -0.0269     0.9760     0.9786     0.0291     0.0247     0.0053     0.0052     0.0051     0
.0051

    25    12    36.9972     5.3901    -4.2069     0.6518     0.0096    -0.0072     0.0063     0.0000     0.0000     0.0178     0
.0212
      0.7863     0.9946    -0.0095     0.0077    -0.3185     0.9844    -0.0095     0.0073     0.0318     0.0310     0.0309     0
.0309
      0.7778     0.9913    -0.0022     0.0017    -0.9703     0.9749    -0.0022     0.0011     0.0514     0.0503     0.0500     0
.0500
      0.0000     0.0000    -0.0269    -0.0269     0.9845     0.9749     0.0182     0.0316    -0.0196    -0.0193    -0.0192    -0
```

```
.0191

  26    13    34.6651     5.3901    -4.2065     0.6136     0.0236    -0.0160     0.0139     0.0000     0.0000     0.0178     0
.0212
   0.7937     0.9975    -0.0143     0.0117    -0.2934     0.9928    -0.0143     0.0116     0.0149     0.0141     0.0141     0
.0141
   0.7728     0.9893     0.0017    -0.0016    -0.9070     0.9692     0.0017    -0.0023     0.0630     0.0617     0.0613     0
.0613
   0.0000     0.0000    -0.0269    -0.0269     0.9929     0.9692     0.0077     0.0393    -0.0481    -0.0475    -0.0472    -0
.0472

  27    14    32.3324     5.3902    -4.2061     0.5403     0.0398    -0.0247     0.0216     0.0000     0.0000     0.0177     0
.0212
   0.8018     1.0006    -0.0194     0.0160    -0.2881     1.0016    -0.0194     0.0160    -0.0031    -0.0038    -0.0038    -0
.0038
   0.7665     0.9867     0.0053    -0.0047    -0.8284     0.9618     0.0053    -0.0055     0.0780     0.0764     0.0759     0
.0758
   0.0000     0.0000    -0.0269    -0.0269     1.0019     0.9618     0.0036     0.0481    -0.0810    -0.0802    -0.0797    -0
.0796

  28    15    29.9996     5.3903    -4.2057     0.4231     0.0656    -0.0397     0.0347     0.0000     0.0000     0.0177     0
.0212
   0.8146     1.0054    -0.0279     0.0231    -0.3068     1.0152    -0.0279     0.0234    -0.0308    -0.0317    -0.0318    -0
.0318
   0.7561     0.9825     0.0119    -0.0101    -0.7299     0.9496     0.0119    -0.0113     0.1027     0.1006     0.0996     0
.0995
   0.0000     0.0000    -0.0270    -0.0270     1.0159     0.9498     0.0211     0.0630    -0.1335    -0.1323    -0.1314    -0
.1313

  29    16    27.6671     5.3902    -4.2053     0.2271     0.1435    -0.0939     0.0817     0.0000     0.0000     0.0177     0
.0212
   0.8544     1.0192    -0.0565     0.0472    -0.3662     1.0551    -0.0565     0.0485    -0.1124    -0.1157    -0.1169    -0
.1166
   0.7257     0.9693     0.0373    -0.0312    -0.5933     0.9116     0.0373    -0.0333     0.1801     0.1745     0.1716     0
.1709
   0.0000     0.0000    -0.0268    -0.0268     1.0578     0.9130     0.0763     0.1137    -0.2925    -0.2902    -0.2884    -0
.2875

  32    17    44.0611     6.8941    -5.4668     0.6451    -0.0028     0.0028    -0.0024     0.0000     0.0000     0.0160     0
.0191
   0.7693     0.9878    -0.0034     0.0023    -0.4654     0.9651    -0.0034     0.0016     0.0708     0.0697     0.0693     0
.0692
   0.7717     0.9887    -0.0062     0.0047    -1.1105     0.9679    -0.0062     0.0040     0.0651     0.0641     0.0638     0
.0637
   0.0000     0.0000    -0.0271    -0.0271     0.9652     0.9679     0.0391     0.0349     0.0057     0.0056     0.0055     0
.0055

  33    18    41.9658     6.8941    -5.4660     0.6518    -0.0021    -0.0022     0.0018     0.0000     0.0000     0.0160     0
.0191
   0.7750     0.9901    -0.0073     0.0058    -0.4002     0.9717    -0.0073     0.0052     0.0574     0.0565     0.0562     0
.0562
   0.7768     0.9909    -0.0050     0.0040    -1.0521     0.9738    -0.0050     0.0034     0.0534     0.0524     0.0521     0
.0521
   0.0000     0.0000    -0.0269    -0.0269     0.9717     0.9738     0.0308     0.0304     0.0041     0.0041     0.0041     0
.0041

  34    19    39.8703     6.8942    -5.4653     0.6513     0.0039    -0.0078     0.0066     0.0000     0.0000     0.0160     0
```

```
.0191
     0.7814     0.9926    -0.0109     0.0086    -0.3496     0.9789    -0.0109     0.0082     0.0428     0.0420     0.0418     0
.0418
     0.7779     0.9913    -0.0031     0.0021    -1.0010     0.9750    -0.0031     0.0016     0.0511     0.0500     0.0498     0
.0498
     0.0000     0.0000    -0.0271    -0.0271     0.9790     0.9750     0.0223     0.0309    -0.0083    -0.0081    -0.0080    -0
.0080

  35     20    37.7751     6.8943    -5.4646     0.6334     0.0137    -0.0133     0.0115     0.0000     0.0000     0.0159     0
.0191
     0.7881     0.9952    -0.0140     0.0115    -0.3148     0.9864    -0.0140     0.0112     0.0275     0.0268     0.0267     0
.0267
     0.7759     0.9906    -0.0007     0.0004    -0.9483     0.9728    -0.0007    -0.0003     0.0557     0.0545     0.0542     0
.0542
     0.0000     0.0000    -0.0270    -0.0270     0.9866     0.9728     0.0137     0.0345    -0.0281    -0.0277    -0.0275    -0
.0275
1
   network id:          index:   1    source type =  0    doublet type = 12    number rows =   8    number columns =   8

  jc    ip       x          y          z          d0         dx         dy         dz         s0         anx        any        a
nz
  lmachu        wxu        wyu        wzu        pheu       vxu        vyu        vzu        cplinu     cpslnu     cp2ndu     cpi
snu
  lmachl        wxl        wyl        wzl        phel       vxl        vyl        vzl        cplinl     cpslnl     cp2ndl     cpi
snl
     wnu        wnl        pwnu       pwnl       vtu        vtl        pvtu       pvtl       cplind     cpslnd     cp2ndd     cpi
snd

  36     21    35.6799     6.8943    -5.4639     0.5927     0.0260    -0.0197     0.0170     0.0000     0.0000     0.0159     0
.0191
     0.7952     0.9980    -0.0179     0.0144    -0.2957     0.9943    -0.0179     0.0143     0.0117     0.0109     0.0109     0
.0109
     0.7720     0.9890     0.0018    -0.0020    -0.8884     0.9683     0.0018    -0.0027     0.0648     0.0635     0.0631     0
.0631
     0.0000     0.0000    -0.0271    -0.0271     0.9945     0.9683     0.0051     0.0402    -0.0532    -0.0526    -0.0522    -0
.0522

  37     22    33.5845     6.8944    -5.4630     0.5225     0.0419    -0.0284     0.0247     0.0000     0.0000     0.0159     0
.0191
     0.8034     1.0011    -0.0229     0.0186    -0.2942     1.0033    -0.0229     0.0187    -0.0066    -0.0074    -0.0074    -0
.0074
     0.7661     0.9866     0.0055    -0.0051    -0.8167     0.9614     0.0055    -0.0060     0.0788     0.0772     0.0766     0
.0766
     0.0000     0.0000    -0.0271    -0.0271     1.0037     0.9614     0.0081     0.0487    -0.0854    -0.0846    -0.0840    -0
.0839

  38     23    31.4892     6.8943    -5.4624     0.4118     0.0690    -0.0454     0.0395     0.0000     0.0000     0.0159     0
.0191
     0.8171     1.0062    -0.0320     0.0267    -0.3148     1.0177    -0.0320     0.0271    -0.0360    -0.0371    -0.0373    -0
.0372
     0.7554     0.9822     0.0133    -0.0112    -0.7266     0.9487     0.0133    -0.0124     0.1046     0.1023     0.1013     0
.1012
     0.0000     0.0000    -0.0268    -0.0268     1.0186     0.9489     0.0268     0.0649    -0.1406    -0.1394    -0.1386    -0
.1384

  39     24    29.3942     6.8939    -5.4617     0.2250     0.1566    -0.1066     0.0926     0.0000     0.0000     0.0159     0
.0191
```

0.8624	1.0217	-0.0639	0.0531	-0.3754	1.0626	-0.0639	0.0545	-0.1277	-0.1320	-0.1335	-0
.1332											
0.7214	0.9673	0.0427	-0.0359	-0.6004	0.9059	0.0427	-0.0380	0.1919	0.1852	0.1819	0
.1810											
0.0000	0.0000	-0.0270	-0.0270	1.0659	0.9077	0.0883	0.1227	-0.3195	-0.3172	-0.3154	-0
.3142											
42 25	44.1269	8.3988	-6.7254	0.6354	0.0002	-0.0095	0.0080	0.0000	0.0000	0.0142	0
.0169											
0.7726	0.9890	-0.0100	0.0078	-0.4399	0.9689	-0.0100	0.0071	0.0628	0.0620	0.0616	0
.0616											
0.7725	0.9891	-0.0005	-0.0002	-1.0752	0.9688	-0.0005	-0.0009	0.0637	0.0625	0.0621	0
.0621											
0.0000	0.0000	-0.0272	-0.0272	0.9690	0.9688	0.0321	0.0380	-0.0009	-0.0005	-0.0005	-0
.0005											
43 26	42.2688	8.3986	-6.7242	0.6339	0.0024	-0.0117	0.0098	0.0000	0.0000	0.0141	0
.0169											
0.7777	0.9910	-0.0125	0.0099	-0.3885	0.9747	-0.0125	0.0093	0.0512	0.0504	0.0502	0
.0501											
0.7756	0.9904	-0.0008	0.0001	-1.0224	0.9723	-0.0008	-0.0005	0.0566	0.0554	0.0551	0
.0551											
0.0000	0.0000	-0.0272	-0.0272	0.9748	0.9723	0.0256	0.0349	-0.0054	-0.0050	-0.0049	-0
.0049											
44 27	40.4108	8.3984	-6.7230	0.6254	0.0075	-0.0148	0.0126	0.0000	0.0000	0.0141	0
.0169											
0.7831	0.9932	-0.0150	0.0120	-0.3482	0.9808	-0.0150	0.0116	0.0388	0.0381	0.0380	0
.0379											
0.7764	0.9908	-0.0002	-0.0004	-0.9737	0.9733	-0.0002	-0.0010	0.0547	0.0535	0.0533	0
.0532											
0.0000	0.0000	-0.0272	-0.0272	0.9810	0.9733	0.0189	0.0347	-0.0159	-0.0154	-0.0153	-0
.0153											
45 28	38.5529	8.3985	-6.7221	0.6045	0.0161	-0.0183	0.0156	0.0000	0.0000	0.0141	0
.0169											
0.7892	0.9956	-0.0174	0.0140	-0.3198	0.9876	-0.0174	0.0137	0.0251	0.0244	0.0243	0
.0243											
0.7748	0.9901	0.0009	-0.0013	-0.9243	0.9715	0.0009	-0.0019	0.0584	0.0571	0.0568	0
.0567											
0.0000	0.0000	-0.0272	-0.0272	0.9878	0.9715	0.0118	0.0370	-0.0332	-0.0327	-0.0324	-0
.0324											
46 29	36.6947	8.3986	-6.7211	0.5641	0.0281	-0.0236	0.0203	0.0000	0.0000	0.0141	0
.0169											
0.7962	0.9983	-0.0206	0.0167	-0.3050	0.9954	-0.0206	0.0166	0.0093	0.0086	0.0086	0
.0086											
0.7711	0.9887	0.0029	-0.0030	-0.8690	0.9672	0.0029	-0.0037	0.0670	0.0656	0.0652	0
.0651											
0.0000	0.0000	-0.0272	-0.0272	0.9957	0.9672	0.0057	0.0420	-0.0576	-0.0570	-0.0566	-0
.0565											
47 30	34.8366	8.3984	-6.7200	0.4978	0.0443	-0.0322	0.0279	0.0000	0.0000	0.0141	0
.0169											
0.8049	1.0016	-0.0256	0.0208	-0.3059	1.0048	-0.0256	0.0209	-0.0098	-0.0106	-0.0106	-0
.0106											
0.7653	0.9863	0.0066	-0.0061	-0.8037	0.9604	0.0066	-0.0070	0.0808	0.0791	0.0785	0

```
.0784
     0.0000      0.0000     -0.0272     -0.0272      1.0053      0.9605      0.0120      0.0503     -0.0905     -0.0897     -0.0891     -0
.0891
1
   network id:            index:   1   source type =  0   doublet type = 12    number rows =   8   number columns =   8
  jc   ip          x           y           z          d0          dx          dy          dz          s0         anx         any          a
nz
  lmachu         wxu         wyu         wzu        pheu         vxu         vyu         vzu      cplinu      cpslnu      cp2ndu        cpi
snu
  lmachl         wxl         wyl         wzl        phel         vxl         vyl         vzl      cplinl      cpslnl      cp2ndl        cpi
snl
     wnu         wnl        pwnu        pwnl         vtu         vtl        pvtu        pvtl      cplind      cpslnd      cp2ndd        cpi
snd

  48   31     32.9791      8.3980     -6.7188      0.3938      0.0734     -0.0501      0.0435      0.0000      0.0000      0.0141      0
.0169
     0.8197      1.0071     -0.0352      0.0291     -0.3278      1.0203     -0.0352      0.0295     -0.0415     -0.0428     -0.0429     -0
.0429
     0.7540      0.9816      0.0149     -0.0128     -0.7216      0.9469      0.0149     -0.0140      0.1082      0.1058      0.1047      0
.1046
     0.0000      0.0000     -0.0270     -0.0270      1.0214      0.9472      0.0315      0.0677     -0.1497     -0.1486     -0.1477     -0
.1475

  49   32     31.1216      8.3979     -6.7179      0.2164      0.1693     -0.1168      0.1013      0.0000      0.0000      0.0141      0
.0169
     0.8697      1.0241     -0.0695      0.0574     -0.3883      1.0693     -0.0695      0.0590     -0.1415     -0.1468     -0.1486     -0
.1481
     0.7171      0.9653      0.0473     -0.0400     -0.6047      0.9000      0.0473     -0.0423      0.2040      0.1963      0.1926      0
.1915
     0.0000      0.0000     -0.0272     -0.0272      1.0732      0.9023      0.0981      0.1312     -0.3455     -0.3431     -0.3411     -0
.3396

  52   33     44.1925      9.9036     -7.9837      0.5979      0.0014     -0.0196      0.0165      0.0000      0.0000      0.0123      0
.0148
     0.7754      0.9900     -0.0154      0.0123     -0.4289      0.9720     -0.0154      0.0116      0.0564      0.0557      0.0554      0
.0554
     0.7741      0.9899      0.0042     -0.0041     -1.0269      0.9705      0.0042     -0.0048      0.0604      0.0589      0.0586      0
.0585
     0.0000      0.0000     -0.0272     -0.0272      0.9722      0.9706      0.0276      0.0407     -0.0040     -0.0032     -0.0032     -0
.0032

  53   34     42.5718      9.9034     -7.9822      0.5938      0.0046     -0.0206      0.0173      0.0000      0.0000      0.0123      0
.0148
     0.7797      0.9918     -0.0174      0.0136     -0.3883      0.9769     -0.0174      0.0131      0.0465      0.0457      0.0455      0
.0455
     0.7756      0.9905      0.0032     -0.0036     -0.9821      0.9723      0.0032     -0.0043      0.0568      0.0553      0.0550      0
.0550
     0.0000      0.0000     -0.0275     -0.0275      0.9772      0.9724      0.0225      0.0386     -0.0103     -0.0096     -0.0095     -0
.0095

  54   35     40.9511      9.9029     -7.9807      0.5827      0.0091     -0.0221      0.0187      0.0000      0.0000      0.0123      0
.0148
     0.7842      0.9935     -0.0189      0.0154     -0.3562      0.9820     -0.0189      0.0150      0.0362      0.0355      0.0354      0
.0354
     0.7761      0.9907      0.0033     -0.0031     -0.9389      0.9729      0.0033     -0.0037      0.0557      0.0543      0.0540      0
.0540
```

```
     0.0000     0.0000    -0.0271    -0.0271     0.9822     0.9729     0.0175     0.0380    -0.0195    -0.0188    -0.0186    -0
.0186

   55    36    39.3304     9.9027    -7.9795     0.5632     0.0167    -0.0239     0.0204     0.0000     0.0000     0.0123     0
.0148
     0.7896     0.9957    -0.0208     0.0164    -0.3323     0.9879    -0.0208     0.0162     0.0242     0.0234     0.0234     0
.0234
     0.7747     0.9901     0.0031    -0.0035    -0.8956     0.9713     0.0031    -0.0042     0.0589     0.0575     0.0571     0
.0571
     0.0000     0.0000    -0.0275    -0.0275     0.9883     0.9713     0.0121     0.0393    -0.0347    -0.0340    -0.0338    -0
.0337

   56    37    37.7098     9.9028    -7.9781     0.5269     0.0293    -0.0281     0.0241     0.0000     0.0000     0.0123     0
.0148
     0.7969     0.9985    -0.0235     0.0187    -0.3200     0.9960    -0.0235     0.0186     0.0080     0.0071     0.0071     0
.0071
     0.7707     0.9885     0.0046    -0.0047    -0.8469     0.9667     0.0046    -0.0055     0.0682     0.0667     0.0662     0
.0662
     0.0000     0.0000    -0.0275    -0.0275     0.9964     0.9667     0.0083     0.0440    -0.0603    -0.0595    -0.0591    -0
.0591

   57    38    36.0892     9.9027    -7.9767     0.4661     0.0467    -0.0362     0.0313     0.0000     0.0000     0.0123     0
.0148
     0.8062     1.0021    -0.0281     0.0228    -0.3224     1.0060    -0.0281     0.0229    -0.0124    -0.0134    -0.0134    -0
.0134
     0.7644     0.9859     0.0082    -0.0075    -0.7885     0.9593     0.0082    -0.0084     0.0831     0.0812     0.0806     0
.0805
     0.0000     0.0000    -0.0273    -0.0273     1.0067     0.9594     0.0154     0.0525    -0.0955    -0.0946    -0.0940    -0
.0939

   58    39    34.4689     9.9023    -7.9753     0.3703     0.0782    -0.0549     0.0476     0.0000     0.0000     0.0123     0
.0148
     0.8222     1.0079    -0.0380     0.0311    -0.3443     1.0229    -0.0380     0.0316    -0.0467    -0.0482    -0.0484    -0
.0484
     0.7521     0.9808     0.0169    -0.0148    -0.7146     0.9447     0.0169    -0.0160     0.1128     0.1101     0.1090     0
.1088
     0.0000     0.0000    -0.0273    -0.0273     1.0241     0.9450     0.0359     0.0712    -0.1595    -0.1583    -0.1574    -0
.1571

   59    40    32.8484     9.9021    -7.9739     0.2042     0.1828    -0.1270     0.1100     0.0000     0.0000     0.0123     0
.0148
     0.8773     1.0265    -0.0749     0.0615    -0.4030     1.0762    -0.0749     0.0632    -0.1555    -0.1618    -0.1640    -0
.1634
     0.7122     0.9630     0.0522    -0.0444    -0.6072     0.8934     0.0522    -0.0468     0.2175     0.2087     0.2045     0
.2032
     0.0000     0.0000    -0.0275    -0.0275     1.0807     0.8962     0.1078     0.1406    -0.3731    -0.3705    -0.3684    -0
.3666
1
   network id:           index:  1   source type =  0   doublet type = 12    number rows =  8   number columns =  8

  jc   ip          x          y          z         d0         dx         dy         dz         s0        anx        any         a
nz
  lmachu         wxu        wyu        wzu       pheu        vxu        vyu        vzu     cplinu     cpslnu     cp2ndu       cpi
snu
  lmachl         wxl        wyl        wzl       phel        vxl        vyl        vzl     cplinl     cpslnl     cp2ndl       cpi
snl
     wnu         wnl       pwnu       pwnl        vtu        vtl       pvtu       pvtl     cplind     cpslnd     cp2ndd       cpi
```

snd

62	41	44.2579	11.4079	-9.2422	0.5332	0.0019	-0.0316	0.0265	0.0000	0.0000	0.0105	0
.0126												
	0.7779	0.9909	-0.0220	0.0173	-0.4324	0.9746	-0.0220	0.0168	0.0508	0.0500	0.0497	0
.0497												
	0.7761	0.9908	0.0096	-0.0091	-0.9657	0.9728	0.0096	-0.0097	0.0564	0.0544	0.0541	0
.0540												
	0.0000	0.0000	-0.0276	-0.0276	0.9750	0.9729	0.0253	0.0447	-0.0056	-0.0044	-0.0043	-0
.0043												
63	42	42.8745	11.4079	-9.2404	0.5290	0.0052	-0.0318	0.0267	0.0000	0.0000	0.0105	0
.0126												
	0.7814	0.9923	-0.0235	0.0182	-0.4007	0.9786	-0.0235	0.0177	0.0428	0.0420	0.0418	0
.0418												
	0.7767	0.9910	0.0083	-0.0084	-0.9297	0.9734	0.0083	-0.0090	0.0550	0.0530	0.0528	0
.0527												
	0.0000	0.0000	-0.0279	-0.0279	0.9790	0.9735	0.0219	0.0432	-0.0122	-0.0111	-0.0110	-0
.0109												
64	43	41.4910	11.4075	-9.2387	0.5189	0.0087	-0.0320	0.0269	0.0000	0.0000	0.0105	0
.0126												
	0.7848	0.9936	-0.0240	0.0196	-0.3750	0.9824	-0.0240	0.0192	0.0350	0.0342	0.0341	0
.0341												
	0.7769	0.9911	0.0080	-0.0071	-0.8939	0.9738	0.0080	-0.0077	0.0542	0.0524	0.0521	0
.0521												
	0.0000	0.0000	-0.0271	-0.0271	0.9829	0.9738	0.0189	0.0421	-0.0192	-0.0182	-0.0180	-0
.0180												
65	44	40.1079	11.4070	-9.2370	0.5042	0.0150	-0.0326	0.0276	0.0000	0.0000	0.0105	0
.0126												
	0.7893	0.9954	-0.0255	0.0199	-0.3543	0.9874	-0.0255	0.0196	0.0250	0.0241	0.0241	0
.0241												
	0.7757	0.9906	0.0071	-0.0073	-0.8584	0.9724	0.0071	-0.0080	0.0570	0.0552	0.0549	0
.0549												
	0.0000	0.0000	-0.0279	-0.0279	0.9879	0.9724	0.0154	0.0426	-0.0320	-0.0311	-0.0308	-0
.0308												
66	45	38.7248	11.4071	-9.2351	0.4755	0.0279	-0.0352	0.0300	0.0000	0.0000	0.0105	0
.0126												
	0.7965	0.9982	-0.0275	0.0215	-0.3428	0.9954	-0.0275	0.0214	0.0090	0.0080	0.0080	0
.0080												
	0.7714	0.9888	0.0077	-0.0079	-0.8183	0.9674	0.0077	-0.0086	0.0669	0.0651	0.0647	0
.0646												
	0.0000	0.0000	-0.0279	-0.0279	0.9960	0.9675	0.0131	0.0465	-0.0579	-0.0570	-0.0566	-0
.0566												
67	46	37.3418	11.4069	-9.2334	0.4248	0.0469	-0.0415	0.0357	0.0000	0.0000	0.0105	0
.0126												
	0.8064	1.0020	-0.0309	0.0250	-0.3443	1.0061	-0.0309	0.0251	-0.0127	-0.0138	-0.0138	-0
.0138												
	0.7644	0.9859	0.0106	-0.0096	-0.7691	0.9593	0.0106	-0.0106	0.0834	0.0814	0.0807	0
.0806												
	0.0000	0.0000	-0.0274	-0.0274	1.0069	0.9594	0.0187	0.0548	-0.0962	-0.0952	-0.0945	-0
.0944												
68	47	35.9585	11.4065	-9.2317	0.3406	0.0821	-0.0598	0.0517	0.0000	0.0000	0.0105	0

Printed by maletour from osprey


```
.0126
    0.8242    1.0086   -0.0408    0.0328   -0.3642    1.0248   -0.0408    0.0334   -0.0507   -0.0524   -0.0526   -0
.0526
    0.7506    0.9801    0.0190   -0.0170   -0.7048    0.9427    0.0190   -0.0183    0.1170    0.1140    0.1127    0
.1125
    0.0000    0.0000   -0.0277   -0.0277    1.0262    0.9431    0.0396    0.0747   -0.1677   -0.1664   -0.1654   -0
.1651

  69    48   34.5750   11.4064   -9.2298    0.1888    0.1978   -0.1381    0.1195    0.0000    0.0000    0.0105    0
.0126
    0.8855    1.0291   -0.0806    0.0657   -0.4193    1.0836   -0.0806    0.0676   -0.1707   -0.1780   -0.1807   -0
.1799
    0.7067    0.9604    0.0575   -0.0493   -0.6081    0.8859    0.0575   -0.0519    0.2330    0.2228    0.2179    0
.2164
    0.0000    0.0000   -0.0279   -0.0279    1.0887    0.8892    0.1182    0.1511   -0.4036   -0.4009   -0.3986   -0
.3962

  72    49   44.3232   12.9125  -10.5007    0.4285    0.0014   -0.0546    0.0457    0.0000    0.0000    0.0087    0
.0104
    0.7803    0.9914   -0.0341    0.0272   -0.4570    0.9768   -0.0341    0.0267    0.0458    0.0446    0.0444    0
.0444
    0.7788    0.9919    0.0204   -0.0185   -0.8854    0.9753    0.0204   -0.0190    0.0519    0.0486    0.0484    0
.0483
    0.0000    0.0000   -0.0278   -0.0278    0.9777    0.9757    0.0308    0.0557   -0.0060   -0.0040   -0.0040   -0
.0039

  73    50   43.1771   12.9122  -10.4987    0.4256    0.0040   -0.0545    0.0457    0.0000    0.0000    0.0087    0
.0104
    0.7828    0.9924   -0.0352    0.0277   -0.4325    0.9795   -0.0352    0.0272    0.0403    0.0390    0.0389    0
.0388
    0.7789    0.9920    0.0193   -0.0179   -0.8581    0.9755    0.0193   -0.0184    0.0515    0.0484    0.0481    0
.0481
    0.0000    0.0000   -0.0281   -0.0281    0.9805    0.9759    0.0297    0.0545   -0.0112   -0.0093   -0.0093   -0
.0092
1
   network id:          index:   1   source type =  0   doublet type = 12    number rows =   8   number columns =   8

  jc   ip        x         y         z        d0        dx        dy        dz        s0       anx       any        a
nz
   lmachu      wxu       wyu       wzu      pheu       vxu       vyu       vzu    cp1inu    cpslnu    cp2ndu      cpi
snu
   lmachl      wxl       wyl       wzl      phel       vxl       vyl       vzl    cp1inl    cpslnl    cp2ndl      cpi
snl
      wnu      wnl      pwnu      pwnl       vtu       vtl      pvtu      pvtl    cp1ind    cpslnd    cp2ndd      cpi
snd

  74    51   42.0309   12.9120  -10.4967    0.4194    0.0065   -0.0537    0.0450    0.0000    0.0000    0.0087    0
.0104
    0.7852    0.9934   -0.0354    0.0282   -0.4115    0.9822   -0.0354    0.0278    0.0348    0.0335    0.0334    0
.0333
    0.7790    0.9920    0.0183   -0.0167   -0.8309    0.9757    0.0183   -0.0172    0.0509    0.0480    0.0477    0
.0477
    0.0000    0.0000   -0.0278   -0.0278    0.9833    0.9760    0.0284    0.0530   -0.0162   -0.0145   -0.0144   -0
.0144

  75    52   40.8853   12.9116  -10.4945    0.4102    0.0110   -0.0534    0.0448    0.0000    0.0000    0.0087    0
.0104
```

	0.7885	0.9947	-0.0361	0.0283	-0.3936	0.9859	-0.0361	0.0280	0.0275	0.0262	0.0261	0	.0261
	0.7782	0.9917	0.0172	-0.0162	-0.8038	0.9748	0.0172	-0.0168	0.0527	0.0498	0.0495	0	.0495
	0.0000	0.0000	-0.0282	-0.0282	0.9869	0.9751	0.0269	0.0524	-0.0252	-0.0236	-0.0234	-0	.0234
76	53	39.7398	12.9114	-10.4924	0.3929	0.0211	-0.0536	0.0452	0.0000	0.0000	0.0087	0	.0104
	0.7941	0.9969	-0.0368	0.0290	-0.3813	0.9921	-0.0368	0.0288	0.0150	0.0136	0.0135	0	.0135
	0.7749	0.9903	0.0168	-0.0157	-0.7742	0.9711	0.0168	-0.0164	0.0602	0.0574	0.0571	0	.0570
	0.0000	0.0000	-0.0281	-0.0281	0.9932	0.9713	0.0254	0.0538	-0.0452	-0.0438	-0.0435	-0	.0435
77	54	38.5940	12.9110	-10.4904	0.3601	0.0390	-0.0560	0.0477	0.0000	0.0000	0.0087	0	.0104
	0.8033	1.0005	-0.0382	0.0309	-0.3780	1.0022	-0.0382	0.0309	-0.0053	-0.0068	-0.0068	-0	.0068
	0.7680	0.9875	0.0178	-0.0159	-0.7382	0.9632	0.0178	-0.0167	0.0760	0.0732	0.0726	0	.0725
	0.0000	0.0000	-0.0276	-0.0276	1.0034	0.9635	0.0269	0.0591	-0.0813	-0.0800	-0.0794	-0	.0793
78	55	37.4480	12.9106	-10.4883	0.2983	0.0783	-0.0700	0.0601	0.0000	0.0000	0.0087	0	.0104
	0.8227	1.0078	-0.0463	0.0364	-0.3905	1.0228	-0.0463	0.0369	-0.0470	-0.0491	-0.0493	-0	.0493
	0.7523	0.9809	0.0238	-0.0219	-0.6887	0.9445	0.0238	-0.0232	0.1138	0.1101	0.1089	0	.1087
	0.0000	0.0000	-0.0285	-0.0285	1.0245	0.9451	0.0437	0.0780	-0.1608	-0.1592	-0.1583	-0	.1580
79	56	36.3021	12.9107	-10.4861	0.1687	0.2123	-0.1512	0.1306	0.0000	0.0000	0.0087	0	.0104
	0.8937	1.0315	-0.0871	0.0708	-0.4378	1.0907	-0.0871	0.0728	-0.1852	-0.1940	-0.1970	-0	.1961
	0.7016	0.9578	0.0641	-0.0550	-0.6066	0.8784	0.0641	-0.0578	0.2483	0.2364	0.2309	0	.2289
	0.0000	0.0000	-0.0282	-0.0282	1.0966	0.8826	0.1291	0.1625	-0.4335	-0.4304	-0.4279	-0	.4250
82	57	44.3885	14.4174	-11.7593	0.2395	-0.0004	-0.1363	0.1141	0.0000	0.0000	0.0069	0	.0083
	0.7852	0.9910	-0.0761	0.0613	-0.5250	0.9777	-0.0761	0.0609	0.0415	0.0350	0.0349	0	.0348
	0.7847	0.9937	0.0602	-0.0526	-0.7644	0.9781	0.0602	-0.0532	0.0487	0.0375	0.0373	0	.0371
	0.0000	0.0000	-0.0285	-0.0285	0.9826	0.9814	0.0781	0.1049	-0.0072	-0.0025	-0.0024	-0	.0024
83	58	43.4799	14.4169	-11.7570	0.2381	0.0018	-0.1356	0.1135	0.0000	0.0000	0.0069	0	.0083
	0.7872	0.9918	-0.0760	0.0618	-0.5067	0.9799	-0.0760	0.0614	0.0371	0.0306	0.0305	0	.0304
	0.7846	0.9936	0.0596	-0.0515	-0.7448	0.9780	0.0596	-0.0521	0.0487	0.0378	0.0375	0	

```
.0374
     0.0000    0.0000   -0.0281   -0.0281    0.9848    0.9812    0.0778    0.1037   -0.0116   -0.0072   -0.0071    -0
.0070

  84    59    42.5713   14.4167  -11.7548    0.2366    0.0029   -0.1345    0.1125    0.0000    0.0000    0.0069     0
.0083
     0.7886    0.9923   -0.0766    0.0612   -0.4894    0.9815   -0.0766    0.0608    0.0340    0.0275    0.0274     0
.0273
     0.7849    0.9938    0.0580   -0.0512   -0.7260    0.9785    0.0580   -0.0517    0.0477    0.0370    0.0368     0
.0366
     0.0000    0.0000   -0.0289   -0.0289    0.9863    0.9816    0.0775    0.1021   -0.0137   -0.0095   -0.0094    -0
.0093

  85    60    41.6630   14.4162  -11.7521    0.2332    0.0049   -0.1330    0.1112    0.0000    0.0000    0.0069     0
.0083
     0.7903    0.9931   -0.0762    0.0612   -0.4741    0.9834   -0.0762    0.0609    0.0301    0.0235    0.0235     0
.0234
     0.7848    0.9938    0.0568   -0.0498   -0.7072    0.9786    0.0568   -0.0503    0.0476    0.0372    0.0370     0
.0369
     0.0000    0.0000   -0.0286   -0.0286    0.9883    0.9815    0.0768    0.1004   -0.0175   -0.0137   -0.0136    -0
.0135
1
   network id:            index:   1   source type =  0   doublet type = 12    number rows =   8   number columns =   8

  jc   ip       x         y         z        d0        dx        dy        dz        s0       anx       any        a
nz
  lmachu       wxu       wyu       wzu      pheu      vxu       vyu       vzu      cplinu    cpslnu    cp2ndu     cpi
snu
  lmachl       wxl       wyl       wzl      phel      vxl       vyl       vzl      cplinl    cpslnl    cp2ndl     cpi
snl
     wnu       wnl       pwnu      pwnl     vtu       vtl       pvtu      pvtl     cplind    cpslnd    cp2ndd     cpi
snd

  86    61    40.7547   14.4158  -11.7497    0.2278    0.0077   -0.1302    0.1088    0.0000    0.0000    0.0069     0
.0083
     0.7923    0.9939   -0.0752    0.0605   -0.4606    0.9858   -0.0752    0.0603    0.0254    0.0191    0.0190     0
.0190
     0.7841    0.9936    0.0550   -0.0480   -0.6884    0.9780    0.0550   -0.0486    0.0485    0.0386    0.0384     0
.0383
     0.0000    0.0000   -0.0285   -0.0285    0.9905    0.9808    0.0752    0.0980   -0.0231   -0.0195   -0.0194    -0
.0193

  87    62    39.8463   14.4154  -11.7475    0.2185    0.0140   -0.1254    0.1050    0.0000    0.0000    0.0069     0
.0083
     0.7955    0.9954   -0.0731    0.0591   -0.4498    0.9898   -0.0731    0.0589    0.0176    0.0116    0.0116     0
.0116
     0.7817    0.9927    0.0523   -0.0454   -0.6683    0.9758    0.0523   -0.0460    0.0529    0.0437    0.0435     0
.0433
     0.0000    0.0000   -0.0282   -0.0282    0.9942    0.9783    0.0722    0.0950   -0.0353   -0.0321   -0.0318    -0
.0317

  88    63    38.9378   14.4150  -11.7451    0.1989    0.0410   -0.1251    0.1052    0.0000    0.0000    0.0069     0
.0083
     0.8084    1.0005   -0.0738    0.0587   -0.4450    1.0040   -0.0738    0.0589   -0.0109   -0.0170   -0.0170    -0
.0169
     0.7706    0.9881    0.0513   -0.0454   -0.6439    0.9631    0.0513   -0.0463    0.0783    0.0693    0.0687     0
.0685
```

```
     0.0000     0.0000    -0.0289    -0.0289     1.0085     0.9655     0.0722     0.0983    -0.0892    -0.0862    -0.0857    -0
.0854
    89    64   38.0294    14.4148   -11.7426     0.1326     0.1914    -0.1885     0.1613     0.0000     0.0000     0.0069     0
.0083
     0.8864     1.0273    -0.1057     0.0857    -0.4642     1.0800    -0.1057     0.0876    -0.1647    -0.1784    -0.1808    -0
.1798
     0.7126     0.9618     0.0828    -0.0712    -0.5968     0.8886     0.0828    -0.0738     0.2290     0.2112     0.2065     0
.2044
     0.0000     0.0000    -0.0286    -0.0286     1.0887     0.8955     0.1404     0.1732    -0.3937    -0.3896    -0.3873    -0
.3842
1
0*b*for-mom-net#-  1
                                    force / moment data for network     1


  totals for column     1       area        fx          fy          fz          mx          my          mz

                               40.29655    0.00000    -0.00355    -0.00424    -0.02639    -0.01477     0.0123
8
                               40.29655    0.00000     0.00999     0.01196     0.07635     0.05750    -0.0480
5
                               40.29655    0.00000     0.00644     0.00771     0.04996     0.04273    -0.0356
7

  totals for column     2       area        fx          fy          fz          mx          my          mz

                               36.57013    0.00000    -0.00156    -0.00186    -0.01623    -0.00475     0.0039
9
                               36.57013    0.00000     0.01074     0.01285     0.11449     0.05956    -0.0497
8
                               36.57013    0.00000     0.00918     0.01099     0.09826     0.05481    -0.0457
9

  totals for column     3       area        fx          fy          fz          mx          my          mz

                               32.84674    0.00000    -0.00043    -0.00051    -0.00566     0.00065    -0.0005
2
                               32.84674    0.00000     0.01025     0.01227     0.14047     0.05580    -0.0466
3
                               32.84674    0.00000     0.00982     0.01176     0.13480     0.05644    -0.0471
5

  totals for column     4       area        fx          fy          fz          mx          my          mz

                               29.12062    0.00000     0.00028     0.00034     0.00478     0.00379    -0.0031
```

5								
		29.12062	0.00001	0.00945	0.01131	0.15828	0.05062	-0.0422
8								
		29.12062	0.00001	0.00972	0.01165	0.16305	0.05440	-0.0454
2								
totals for column	5	area	fx	fy	fz	mx	my	mz
		25.40189	0.00000	0.00073	0.00088	0.01453	0.00560	-0.0046
5								
		25.40189	0.00001	0.00845	0.01012	0.16733	0.04459	-0.0372
3								
		25.40189	0.00001	0.00917	0.01100	0.18186	0.05018	-0.0418
8								
totals for column	6	area	fx	fy	fz	mx	my	mz
		21.67510	0.00000	0.00094	0.00114	0.02161	0.00619	-0.0051
4								
		21.67510	0.00001	0.00726	0.00870	0.16598	0.03775	-0.0315
2								
		21.67510	0.00001	0.00820	0.00984	0.18759	0.04394	-0.0366
6								
totals for column	7	area	fx	fy	fz	mx	my	mz
		17.95490	0.00000	0.00085	0.00103	0.02206	0.00525	-0.0043
6								
		17.95490	0.00001	0.00580	0.00695	0.14997	0.02966	-0.0247
6								
		17.95490	0.00001	0.00665	0.00797	0.17204	0.03491	-0.0291
2								
totals for column	8	area	fx	fy	fz	mx	my	mz
		14.22880	0.00000	0.00037	0.00045	0.01058	0.00233	-0.0019
4								
		14.22880	0.00001	0.00352	0.00422	0.10168	0.01772	-0.0147
9								
		14.22880	0.00001	0.00389	0.00467	0.11226	0.02005	-0.0167
3								
totals for network		area	fx	fy	fz	mx	my	mz
		218.09473	0.00000	-0.00237	-0.00279	0.02527	0.00427	-0.0033
9								
		218.09473	0.00005	0.06546	0.07837	1.07455	0.35320	-0.2950

```
3
                                   218.09473     0.00006     0.06308     0.07559     1.09982     0.35747    -0.2984
2

 totals for all networks so far    area          fx          fy          fz          mx          my          mz

                                   218.09473     0.00000    -0.00237    -0.00279     0.02527     0.00427    -0.0033
9
                                   218.09473     0.00005     0.06546     0.07837     1.07455     0.35320    -0.2950
3
                                   218.09473     0.00006     0.06308     0.07559     1.09982     0.35747    -0.2984
2
0*e*for-mom
1
    network id:            index:   2    source type =  0    doublet type = 12    number rows =   8    number columns =   8
  jc    ip        x          y          z          d0         dx         dy         dz         s0         anx        any        a
nz
  lmachu          wxu        wyu        wzu        pheu       vxu        vyu        vzu        cplinu     cpslnu     cp2ndu     cpi
snu
  lmachl          wxl        wyl        wzl        phel       vxl        vyl        vzl        cplinl     cpslnl     cp2ndl     cpi
snl
     wnu          wnl        pwnu       pwnl       vtu        vtl        pvtu       pvtl       cplind     cpslnd     cp2ndd     cpi
snd

  112     65     43.9301    -2.9497    -3.8857    -0.3830     0.0239     0.1109     0.1332     0.0000     0.0000     0.0234    -0
.0196
     0.7810      0.9895     0.0571     0.0684    -1.0960     0.9741     0.0571     0.0679     0.0483     0.0439     0.0437     0
.0436
     0.7609      0.9839    -0.0538    -0.0641    -0.7130     0.9501    -0.0538    -0.0653     0.1054     0.0928     0.0918     0
.0914
     0.0000      0.0000     0.0222     0.0222     0.9781     0.9539     0.0669     0.1218    -0.0571    -0.0489    -0.0481    -0
.0477

  113     66     41.3597    -2.9495    -3.8858    -0.4581     0.0263     0.0643     0.0775     0.0000     0.0000     0.0234    -0
.0196
     0.7883      0.9942     0.0345     0.0412    -1.0532     0.9853     0.0345     0.0409     0.0278     0.0266     0.0265     0
.0265
     0.7655      0.9864    -0.0298    -0.0356    -0.5950     0.9590    -0.0298    -0.0366     0.0857     0.0800     0.0793     0
.0791
     0.0000      0.0000     0.0224     0.0224     0.9867     0.9601     0.0302     0.0842    -0.0579    -0.0534    -0.0528    -0
.0526

  114     67     38.7894    -2.9495    -3.8858    -0.5064     0.0122     0.0308     0.0371     0.0000     0.0000     0.0234    -0
.0196
     0.7849      0.9936     0.0181     0.0216    -1.0143     0.9826     0.0181     0.0212     0.0345     0.0340     0.0339     0
.0339
     0.7743      0.9901    -0.0127    -0.0152    -0.5079     0.9705    -0.0127    -0.0159     0.0614     0.0587     0.0584     0
.0583
     0.0000      0.0000     0.0224     0.0224     0.9830     0.9707     0.0168     0.0553    -0.0269    -0.0248    -0.0245    -0
.0245

  115     68     36.2197    -2.9493    -3.8859    -0.5195    -0.0020     0.0076     0.0091     0.0000     0.0000     0.0234    -0
.0196
     0.7800      0.9921     0.0066     0.0081    -0.9653     0.9774     0.0066     0.0076     0.0459     0.0451     0.0449     0
```

LIST OF REFERENCES

1. Epton, M., Magnus, A., "PAN AIR - A Computer Program for Predicting Subsonic or Supersonic Linear Potential Flows About Arbitrary Configurations Using a Higher Order Panel Method", Volume I - Theory Document (Version 3.0), NASA Contractor Report 3251, Ames Research Center, Moffett Field, CA., March 1992.

2. Bertin, J. J., and Smith, M. L., Aerodynamics for Engineers, 2nd ed., Prentice-Hall, 1989.

3. Anderson, J. D., Fundamentals of Aerodynamics, 2nd ed., McGraw-Hill, 1991.

4. Saaris, G. R., "A502i User's Manual-PAN AIR Technology Program for Solving Problems of Potential Flow about Arbitrary Configurations", Boeing Document Number D6-54703, Boeing, February 1992.

5. Cenko, A., "Determination of Correct AIWS Carriage Loads", Report Number NAWCADAWR-92095-60, Naval Air Warfare Center Aircraft Division, Warminster, PA., June 1992.

6. Cenko, A., Tinoco, E., Dyer, R., DeJongh, J., "PAN AIR Applications to Weapons Carriage and Separation", AIAA Paper 80-0187, 18th Aerospace Sciences Meeting, Pasadena, CA, January 1980.

7. Cenko, A., Talbot, M., Piranian, A., "Analysis of the F-14/GBU-24 and Wind Tunnel Test", Air Vehicle and Crew Systems Technology Department (Code 6053), Naval Air Warfare Center Aircraft Division, Warminster, PA., December 1995.

8. Johnson, F., Samant, S., Bieterman, M., Melvin, R., Young, D., Bussoletti, J. Hilmes, C., "TranAir: A Full-Potential, Solution-Adaptive, Rectangular Grid Code for Predicting Subsonic, Transonic, and Supersonic Flows about Arbitrary Configurations", Theory Document, NASA Contractor Report 4348, Ames Research Center, Moffett Field, CA., December 1992.

9. Keube, F., "Low Apsect Ratio Wings with Small Thickness at Zero Lift in Subsonic and Supersonic Flow", KTH-Aero TN21, Royal Institute of Technology, Stockholm, Sweden, June 1952.

10. Hermstad, D., RAID User's Guide, NASA Ames Division Federal Systems Group, Sterling Software, Inc., Palo Alto, CA., March 1991.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center.. 2
   8725 John J. Kingman Rd., STE 0944
   Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library..2
   Naval Postgraduate School
   Monterey, CA 93943-5100

3. Chairman...1
   Department of Aeronautics and Astronautics, Code AA
   Naval Postgraduate School
   Monterey, CA 93943-5000

4. Dr. Max F. Platzer...5
   Department of Aeronautics and Astronautics, Code AA/PL
   Naval Postgraduate School
   Monterey, CA 93943-5000

5. Dr. Kevin Jones...1
   Department of Aeronautics and Astronautics, Code AA/Jo
   Naval Postgraduate School
   Monterey, CA 93943-5000

6. Dr. Ismail Tuncer...1
   Department of Aeronautics and Astronautics, Code AA/Tu
   Naval Postgraduate School
   Monterey, CA 93943-5000

7. LT Matthew LeTourneau..1
   Department of Aeronautics and Astronautics, Code 31
   Naval Postgraduate School
   Monterey, CA 93943-5000